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CONTENTS

HEREDITY IN THE HONEY BEE.....P. W. WHITING 3
AN HEREDITARY NOTCH IN THE EARS OF JERSEY CATTLE
..... J. L. LUSH 8
MATRIMONIAL VIEWS OF UNIVERSITY STUDENTS
..... HARRISON R. HUNT 14
A GERMAN STATEMENT OF EUGENICS (a review)..... 21
BIOLOGY AND RELIGION (a review)..... 21
A CASE OF TWINNING IN DAIRY CATTLE.....C. C. HAYDEN 22
THE TEMPERATURE OF THE MELTING POT (a review)..... 25
MICROCEPHALIC PEOPLE SOMETIMES CALLED "PIN HEADS"
..... CHAS. BERNSTEIN 30
PRESENT STATUS OF THE JOURNAL OF HEREDITY..... 39
ORIGIN OF FALSE WILD OATS.....R. J. GARBER 40

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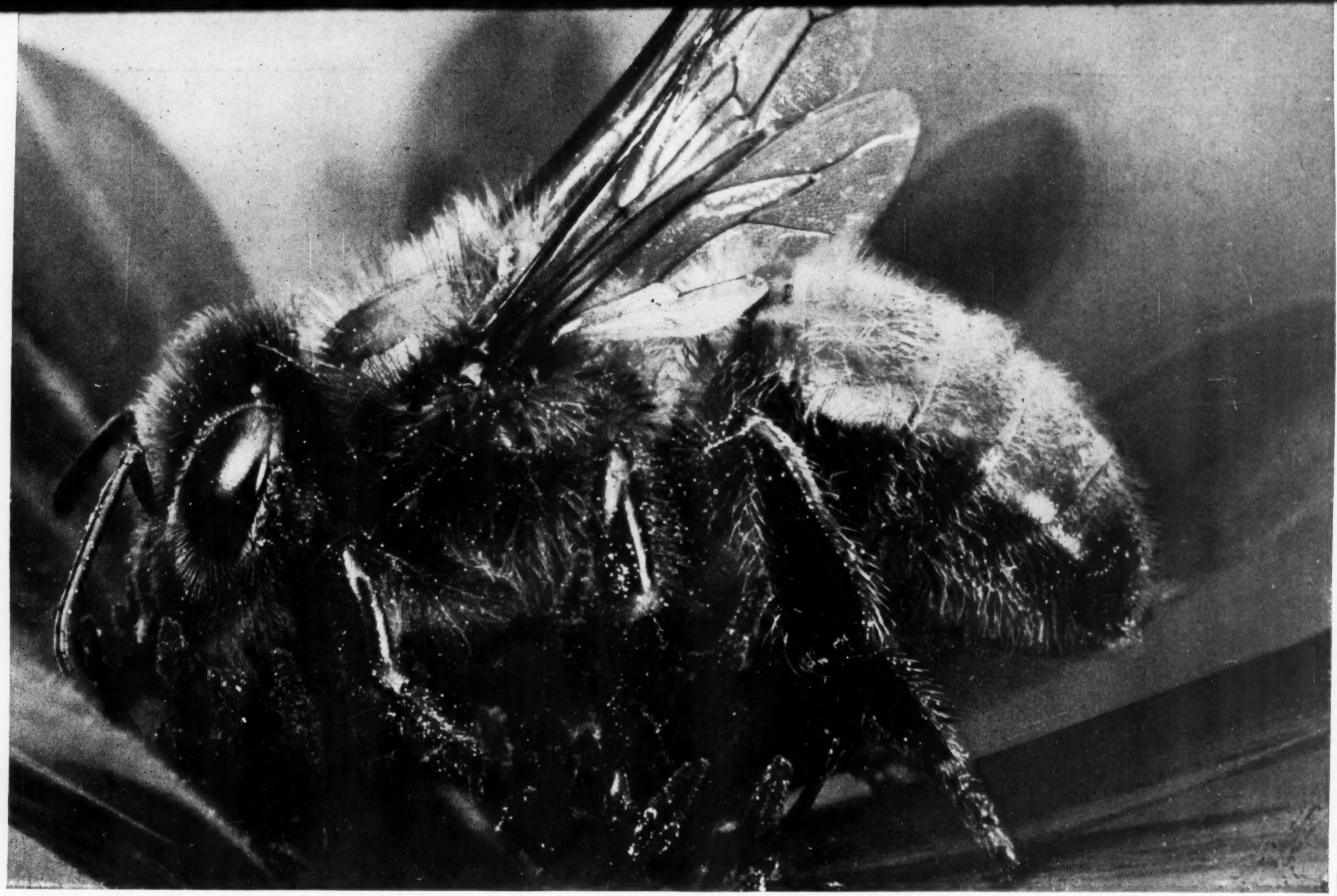


THE HONEY BEE AT WORK

The parents of this worker were a drone and a queen bee. The drone is proverbial for laziness and helplessness. The only useful function in the economy of the hive that he performs is to fertilize the queen during the marriage flight, and very few drones ever do this. The queen is specialized to lay eggs. Neither of the parents is equipped with the workers' marvelous food gathering and housekeeping instincts. How these instincts have been transmitted for thousands of years through a line of queens and drones is an interesting problem in heredity. (Photo by

HEREDITY IN THE HONEY-BEE

P. W. WHITING
Child Welfare Research Station, State University of Iowa

IT IS now generally recognized that inheritance in the honey-bee is of a criss-cross type due to the fact that males or drones arise from unfertilized eggs and thus inherit maternal characters only. Females, both workers and queens, come from fertilized eggs and thus show paternal as well as maternal qualities. These three castes are strikingly different from each other both in structure and in instincts. From measurements made by v. Alten and published by Armbruster it appears that the "brain-index" of workers is superior to that of the queen and the latter again superior to that of the drone. Degeneration of the queen brain is correlated with degeneration of instincts due to a "parasitic" life upon the worker colony. Instincts as well as brain of the drone are likewise far inferior to that of the workers.

PROBLEMS OF HEREDITY

In a recent book on bees ("A Book about the Bee" by Herbert Mace) occur the following remarks:

"The curious problem, and one that is not to be explained by any law that we are cognisant of, is that the workers with all their wonderful cell-building, pollen-gathering, and honey-storing appliances and instincts, descend from parents who have never done anything of the kind, having neither the organs nor the requisite amount of intelligence. How is this complex instinct transmitted?"

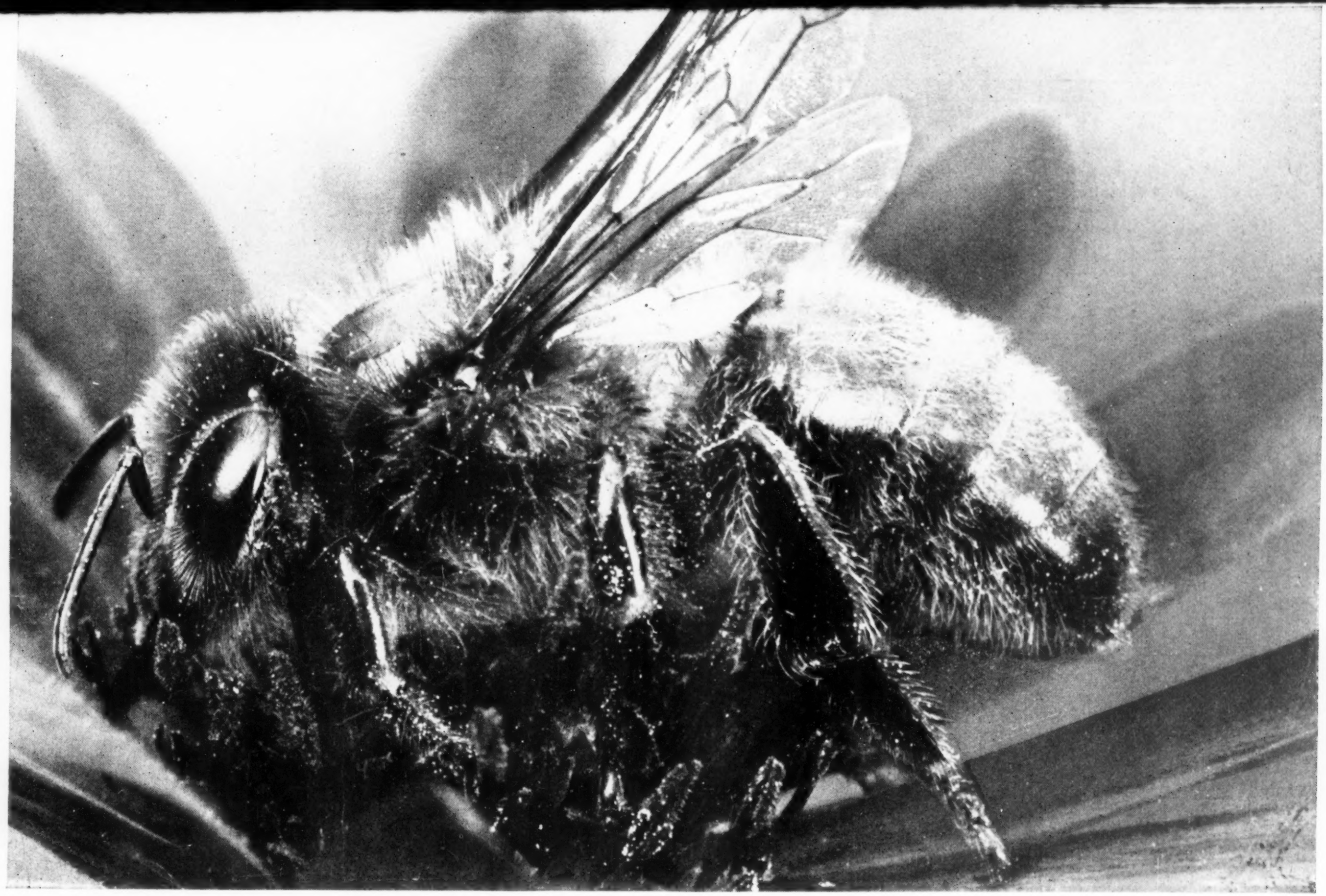
"The drone is a male bee, having neither the organs nor the intelligence to perform the necessary functions of existence apart from the colony. The queen is more or less in like case. Neither is able to find food for itself. Neither has ever had anything to do with the rearing of the young. Yet the product of the two is, under ordinary circumstances, an insect endowed with special apparatus for carrying home honey and pollen in quantities truly remarkable for the size of the creature. Its tongue, honey sac, and pollen baskets are developed in a measure that has no comparison with those of its parents. In addition it possesses a much higher degree of intelligence as calculated by brain area."

"The female or queen bee, contains within her own person the means of reproducing bees, but not bees that are in any way like herself. Her unassisted progeny is of a kind entirely different in its organic structure. In this she differs from the aphides. The offspring of a virgin aphis is like herself, a female."

" . . . drones have a mother, but no father. How comes it then that they possess the virtues, or perhaps we should say vices, of a parent who has taken no part in their production?

"Of course it is true that the drones which come from a certain queen are generally pure, that is to say, the particular variety of bee, whether Black, Italian, or Carniolan, which the queen belongs to is perpetuated in the drone."

"Skilled apiarists know well that qualities, even to the minute shades of difference are thus perpetuated. A stock that is naturally vicious and inclined to sting at every opportunity can be cured of the propensity by removing the queen and substituting one from another and more gentle colony. On the other hand if we have a colony which is notable for its devotion to work, for its capacity to extract honey from specially inaccessible flowers, or for the exceptional colour and beauty of its wax, we take great pains to rear future queens from that colony, knowing that their offspring will assuredly possess the same qualities. And yet, so far as we can trace back through the ages, the queen has never performed any of the duties so pre-eminent in her offspring."



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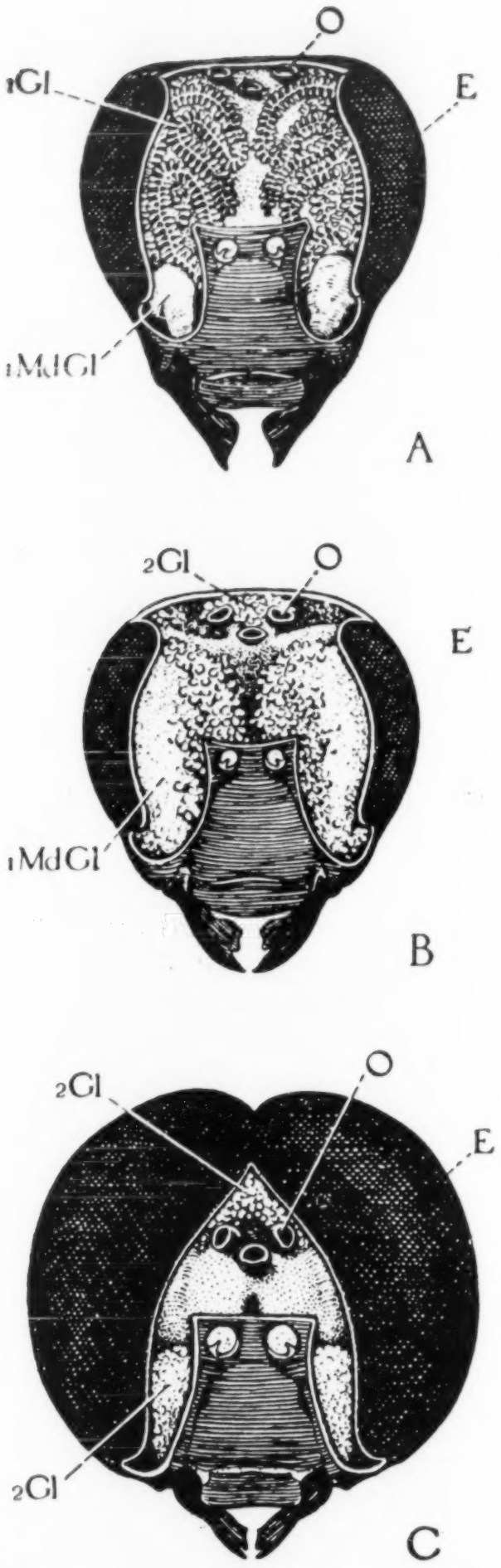


ANTERIOR VIEW OF HEADS OF WORKER (A), QUEEN (B) AND DRONE (C)

The front chitin has been removed to show the internal glands, which vary in the three forms. There is marked variation in the size of the compound eyes at the sides of the head. After Snodgrass Bull. Bureau Ent. 28. (Fig. 1.)

Let us attempt from three different points of view to attack these problems that seem so perplexing.

THE GENETICIST'S METHOD OF ATTACK

In the first place we may consider the matter as viewed by the geneticist. There are numerous instances of transmission of qualities that appear only under the influence of particular environmental conditions. The germ plasm of any species doubtless has potentialities that are realized only under exceptional circumstances or not at all. Thus the factor for extra legs in Drosophila is inherited as a sex-linked gene, but the character appears only if development takes place at a cold temperature. A study of genetic literature reveals many other examples of masking of Mendelian differences by environment. In stock of uniform genetic character there may be considerable variation as a result of change of food, temperature, humidity, etc.

It may then be answered that workers are of the same genetic constitution as the queen, but a difference of food has dwarfed the ovaries and caused a greater development of brain and instincts. The fact that superior instincts have not occurred in any of the worker bee's direct ancestors is quite in line with the problem of heredity as viewed from the aspect of cell lineage. We receive our hereditary characters not from the body cells of our parents, but from the germ tract extending back indefinitely. The somatic cells of our ancestors are "sisters" to their germ cells, and "aunts" and "great aunts" to our own, just as worker bees are sisters to queens and drones and aunts and great aunts to later generations of workers.

The germ plasm of the honey bee has the capacity to develop worker as well as queen qualities, and the difference between worker and queen is determined by the food of the larva.

The difficulty which appears in the derivation of drones from virgin queens, is again due to the idea that characters are inherited as such from the parent. The drone does not derive its characters from egg-laying workers or unmated queens. On the contrary it derives a simplex assortment of genetic factors or of chromosomes in the unfertilized egg. This simplex condition determines the male, just as the duplex determines the female. If honey-bees were able to lay unreduced eggs, as are various species of parasitic wasps and aphids, then females would be produced parthenogenetically. Or if two sperm

nuclei could unite in an egg without an egg nucleus, then a female might result possessing all the racial characteristics of the father, but in every way a normal female.

The determination of sex then is not due to the source of the germinal material but rather to its quantity. In other words each caste,—drone, queen, or worker—transmits the very same genetic complex, including factors for racial differences in color, form, and instinct, and the genetic potentiality of producing male, queen or worker according to conditions. A simplex genetic assortment produces a male, a duplex produces a female,—a queen in case of royal feeding, a worker in case of worker feeding.

THE PHYLOGENETIC POINT OF VIEW

Let us consider the matter now from the point of view of phylogeny. What has caused the complicated instincts of the workers to be developed and what maintains these instincts at their present high level? In a word, how has natural selection acted upon the reproductive castes so carefully guarded and cared for by the workers?

For the one brief marriage flight of her life the queen must have strong wings to fly and keen senses to observe landmarks so that she may return to her hive. Failing in this one test she loses all chances of posterity. Moreover her mate must be superior to his fellows in speed of wing and sureness of vision. The marriage flight is indeed a eugenic test and selection of the superior male. Germ plasm then of queen and drone must bear factors for superior sensory apparatus and strong wings and muscles.

But the germ plasm of the royal pair must carry factors also for industry in collecting honey and pollen and in constructing combs and caring for the young or the colony as a whole will fail. Relatively high fertility must also be present for scarcity of eggs would result in small numbers of workers and scarcity of sperm would result in failure of fertilization giving excess of drones.

Natural selection acts upon the colony as a unit, and the character of the colony is genetically determined by the queen mother and her mate. The hive having greater industry, more socialized instincts, stronger wings and keener senses will survive under adverse conditions, show better capacity for adaptation, and thus have greater chances of posterity.

THE PHYSIOLOGICAL POINT OF VIEW

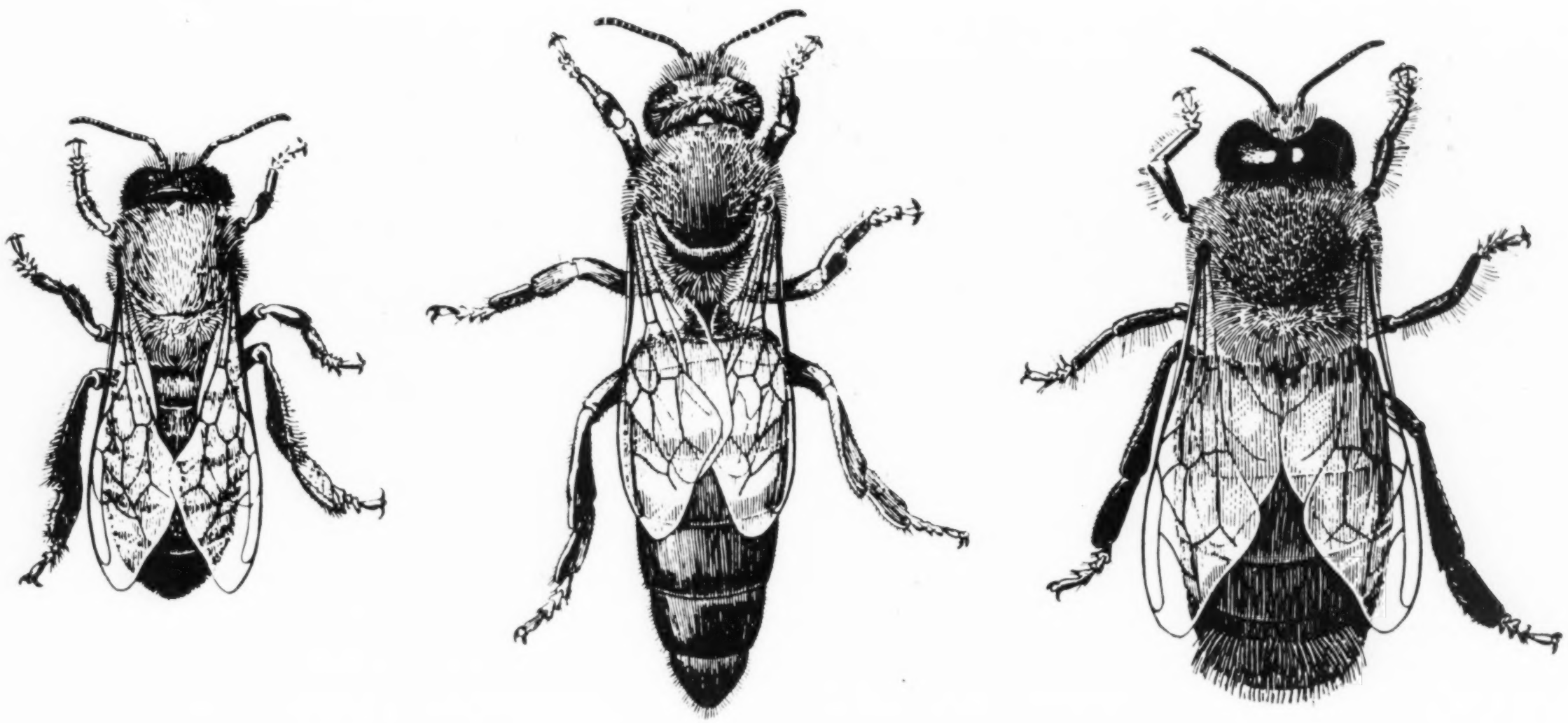
Finally from the physiological point of view there are numerous interesting problems concerning the differentiation of the castes.

It may be supposed that there are factors located in the various chromosomes tending to pull the course of development in the female direction. These would have a tendency to suppress male characters, both primary and secondary, but would stimulate the development of embryological fundaments of female characters. These factors are, however, too weak to act unless doubled, and hence the simplex condition produces a male, the duplex a female.

Queens and workers, although similar genetically, are distinct before they have had experience with the outer world. Differentiation is therefore due, not to active experience, but to feeding. A comparison may be made here with a situation in poultry. If ovaries be removed from a pullet, male form and plumage are developed, as well as male instincts, voice, etc. Now the effect of worker food in bees has been degeneration, or rather failure of development, of the ovaries. The queen may then be compared to the normal egg-laying hen, while the worker may be compared to the hen with ovaries removed, possessing characters that are normally suppressed by ovarial activity.

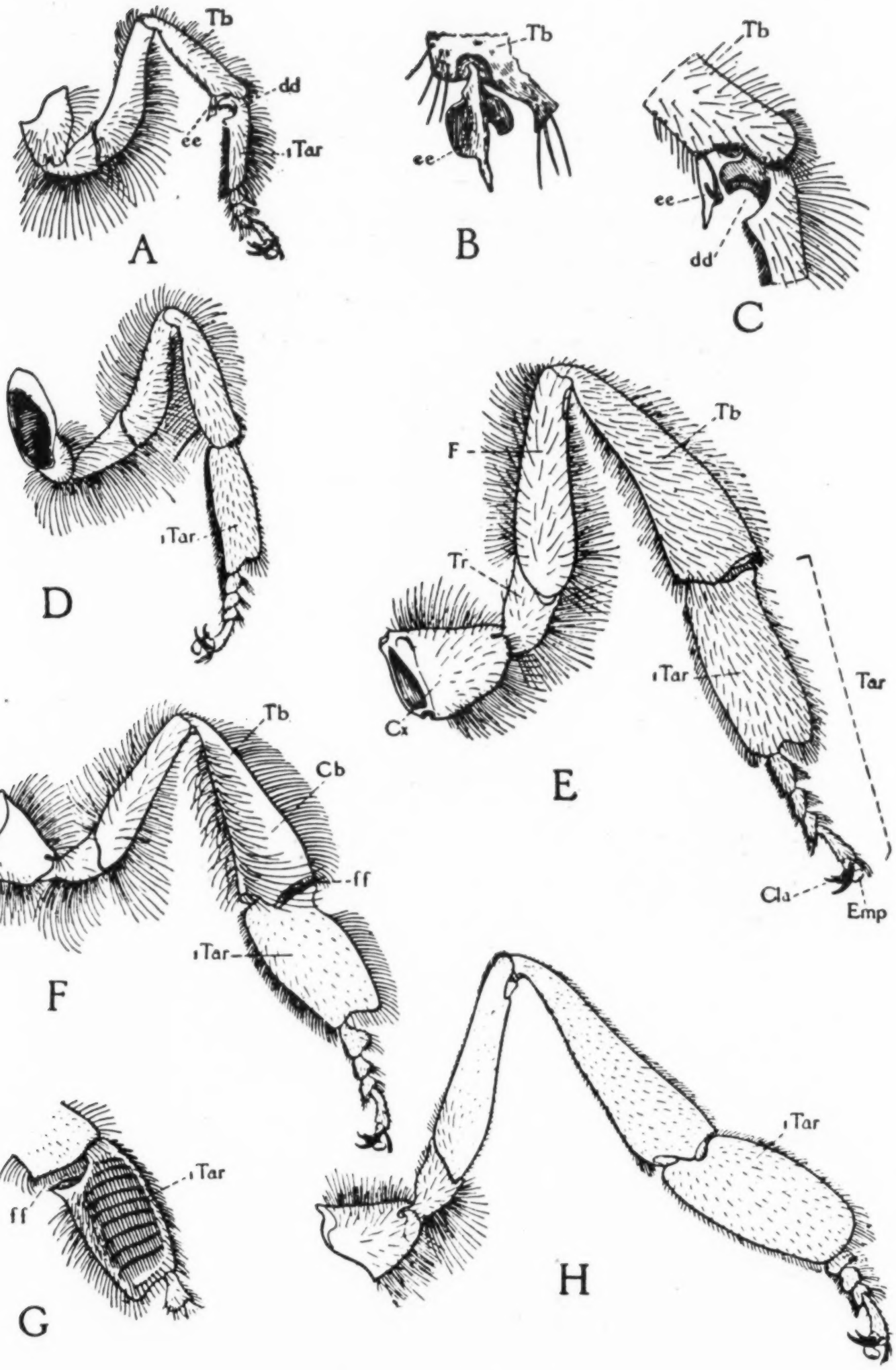
EGG-LAYING WORKERS

Intergrades between sexual and worker castes normally occur in bumble-bees, and in the honey bee, intergrades, such as egg-laying workers, are not unusual. Worker larvae, developing near queen cells, obtain royal jelly



THE WORKER, QUEEN, AND DRONE OF THE HONEY BEE

Both workers and queens are developed from a fertilized egg, and the difference in adult forms is brought about by feeding during the larval stage. The drones, or male bees, develop from unfertilized eggs, so that only maternal characteristics are inherited, as they have no fathers. After Phillips, Farmers Bull. 447. (Fig. 2.)



LEGS OF HONEYBEES

A, left front leg of worker, anterior view; *B*, Spine of antenna cleaner; *C*, Details of antenna cleaner; *D*, Left middle leg of worker, anterior view; *E*, Left hind leg of queen, anterior view; *F*, Left hind leg of worker, anterior view; *G*, Inner view of left hind leg of worker showing pollen-combs; *H*, Left hind leg of drone, anterior view. The honeybee carries many of its tools as leg appendages and these vary in the three types of bees. After Snodgrass Bull. Bureau Ent. 18. (Fig. 3.)

in addition to their regular worker food, and in this way are produced intermediate types resembling the bumble-bees in being capable of both work and reproduction, but probably of each to a lesser extent than the normal queen or worker. High specialization including differentiation of worker from queen has made for greater efficiency in the honey-bee colony.

AN HEREDITARY NOTCH IN THE EARS OF JERSEY CATTLE[1]

Superficial Appearance of This Character Would Appear to Fit Theory of Inheritance of Acquired Characters

JAY L. LUSH
Texas Agricultural Experiment Station

THE principal Jersey sire of the dairy herd at the Texas A. & M. College, Gamboge's Raleigh 109548, is characterized by a peculiarly shaped ear which he has transmitted to a large number of his calves. The author's attention was called to this upon his arrival at the Texas Experiment Station last September, and through the co-operation of Prof. R. L. Pou, head of the Dairy Department and W. L. Pou, dairy herdsman, it has been possible to make a tentative analysis of the genetic situation.

The case is particularly interesting in that the oddness of the ear shape consists of a notch on the lower edge of the ear which is very similar to a mark commonly used on the range for identification, the so-called "undersloped" or "underbit" ear. Hence many a casual visitor would assume that the bull's ears were artificially "undersloped," and the fact that his calves are born with "undersloped" ears would apparently constitute proof that an acquired character is being inherited. The origin of the mark could not be learned, for this bull is now over nine years old and was bought as a suckling calf by C. S. Gainer, Bryan, Texas. Mr. Gainer noticed the mark distinctly at the time and there then seemed to be no sign of a scar. A letter addressed to The White Horse Farms, Paoli, Pennsylvania, breeders of this bull, did not receive a reply and it is not known whether his sire or dam had this mark. Therefore, it is necessary to start with this bull in studying the situation, since knowledge of the notch begins with him.

Only one other case similar to this has been found. The Jersey bull, "Fern's Texas Lad" 96298, which was owned at one time by J. F. Houchins, Hallettsville, Texas, "had both of his ears marked with an underslope and

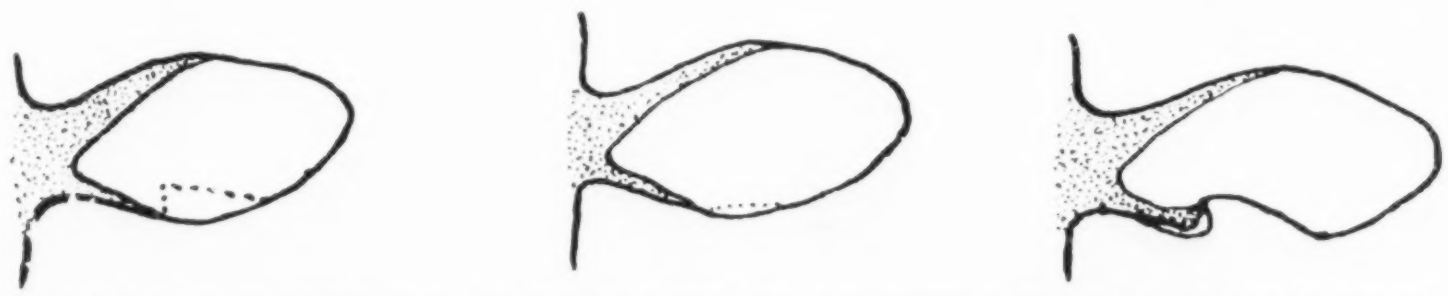
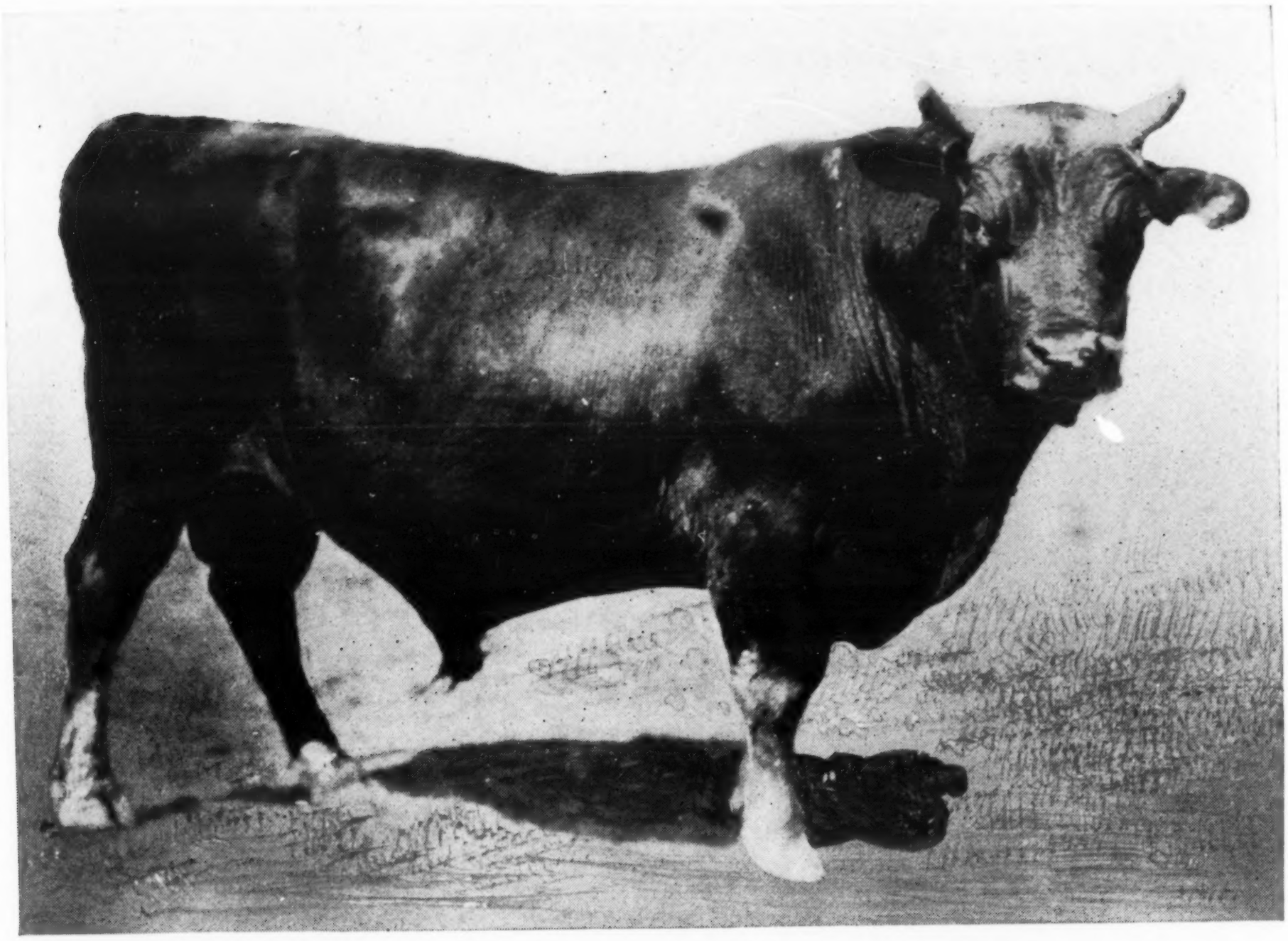


DIAGRAM SHOWING THE POSITION OF THE HEREDITARY NOTCH

On the left is shown the shape and position of the notch in the "underbit" ear, used as a mark by stockmen. The other two figures show the extreme variations in the size of the hereditary notch. (Fig. 4.)

[1] Paper No. 1, in Animal Genetics, from the Texas Agricultural Experiment Station.



GAMBOGE'S RALEIGH, WHOSE NOTCHED EARS ARE INHERITED BY HIS DESCENDANTS

The similarity of this notch to that in the artificially "underbit" ear would lead the layman to conclude that an acquired characteristic had been inherited. (Fig. 5.)

rounded crop,[2] and many of his get (but less than half of them) had this mark."

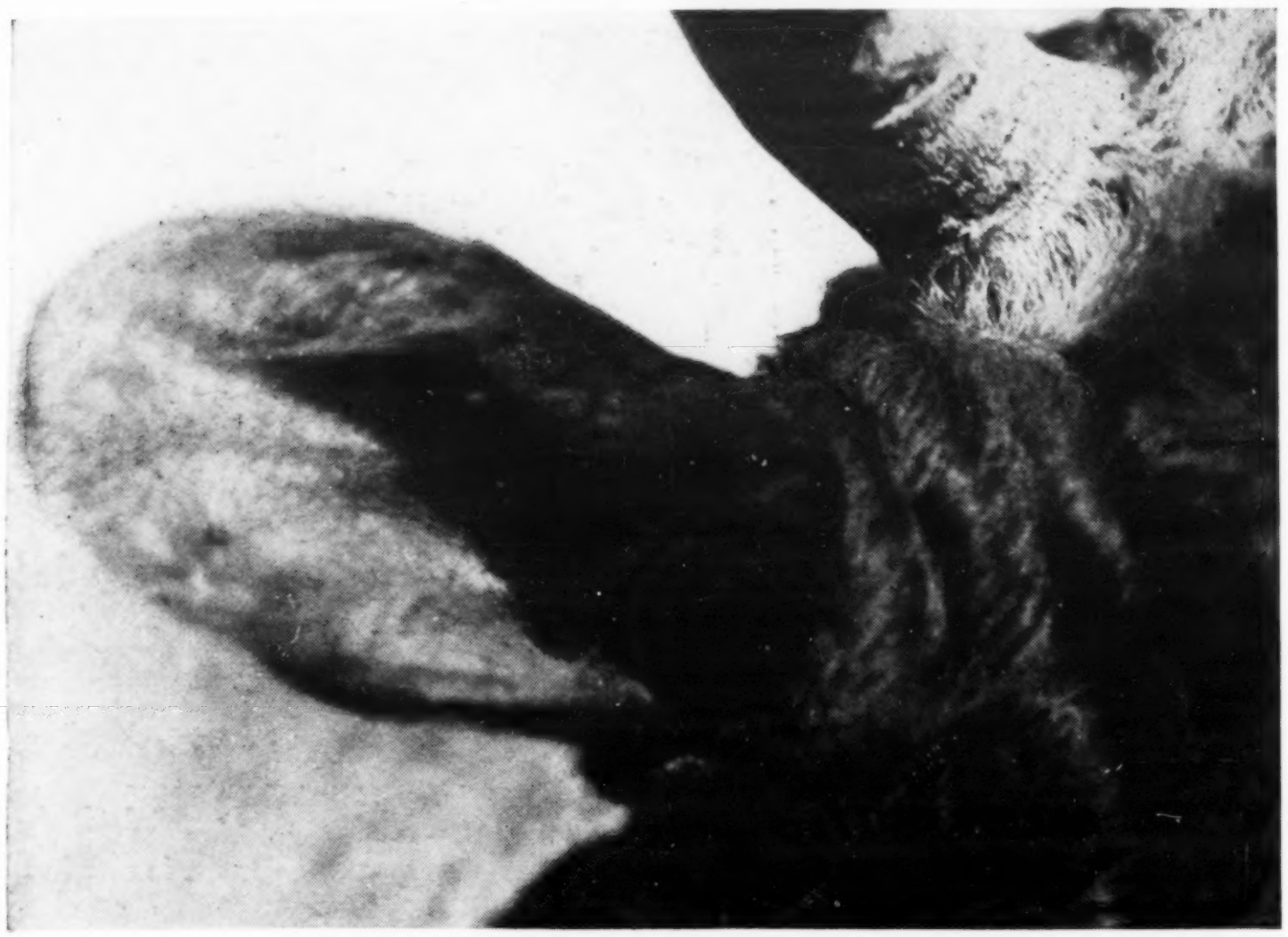
When viewed from the front the ears of Gamboge's Raleigh appear to have had a piece clipped neatly out of them. The outer end of the notch merges rather gradually into the natural curve of the ear, while the other end of the notch makes an acute angle with the ear's lower edge, leaving a sharp corner projecting downward and outward as shown in Figures 4–7. Close examination reveals the fact that this projection is really doubled in both ears, although more distinctly in the left than in the right. The doubling occurs as a front and a rear projection, and the groove between them is about a half inch deep in the case of the left ear and about a quarter inch deep in the case of the right. Some evidence of this doubling is visible in the pictures.

Were it not for the fact that so many of his offspring possess this notch, the condition could be regarded as an accident of development. It might be due either to a sporadic attempt at doubling of the ear or to a blocking of the blood vessel which would have supplied the missing portion of the ear during early embryonic life. Possibly this is the mechanism by which the hereditary factors act to bring about such a result, but there can be no doubt that this result is due to definite hereditary factors and not to mere prenatal accidents.

NOT SEX-LINKED

Thirty of the calves of Gamboge's Raleigh were examined personally by the writer and twelve were found to

[2] The expression "rounded crop" means to the stockman that the outer end of the ear has been cut off leaving it less pointed than is normal.



RIGHT EAR OF GAMBOGE'S RALEIGH

Quite often the development of the notch is greater in one ear than in the other, but the larger notch occurs just as often in the right ear as in the left. The notch in the left ear is slightly larger in this animal. (Fig. 6.)

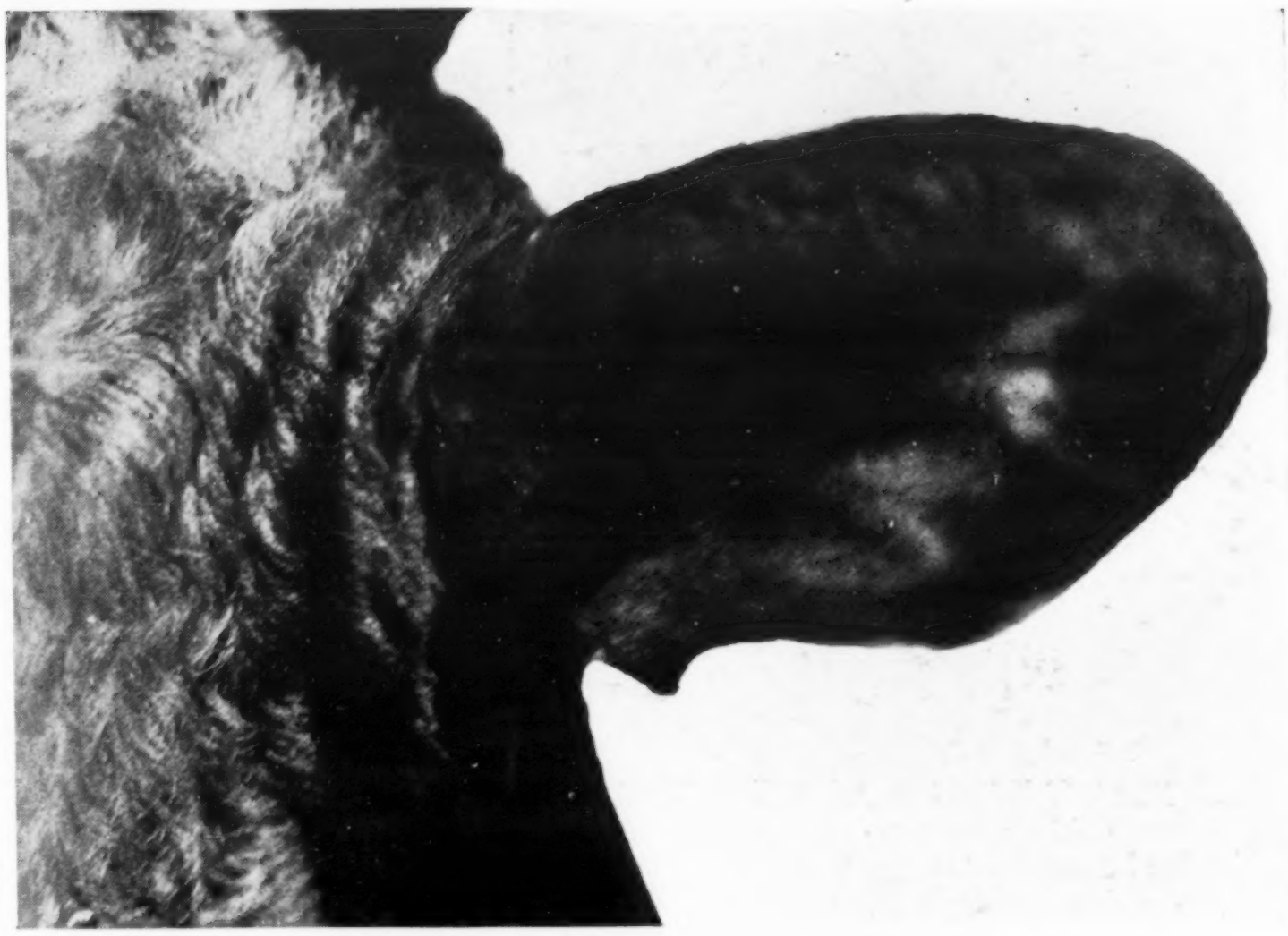
be normal. At the time of examination the sex of twenty-seven of these offspring was noted, and fourteen females and three males were recorded among those with notched ears, and nine females and one male among those with normal ears. The excess of females is due to the fact that the bulls had been disposed of as soon as weaned, but most of the heifers had been retained, thus making more females available for examination. Had the character been a simple sex-linked recessive, it would not have shown in any of the offspring, while if it had been a simple sex-linked dominant it would have shown in all of the daughters but none of the sons.

Two calves sired by unrelated bulls, out of daughters of Gamboge's Raleigh, were examined. Both calves had normal ears. The mother of one of them had normal ears and the mother of the other had ears almost or quite as deeply notched as those of Gamboge's Raleigh, himself.

A SINGLE DOMINANT FACTOR

The only tenable hypothesis seems to be that the notched ear is due to a single dominant factor independent of sex. If Gamboge's Raleigh is heterozygous for this factor, his calves should be equally divided between those with notched and those with unnotched ears. The actual results of 12 normal and 18 notched, deviate only three from expectation. Since the probable error is 1.8, this deviation cannot be regarded as significant. The normal daughter produced a normal calf as expected, and the notched daughter, that should produce normal and notched calves in equal numbers, has thus far produced one normal calf. Further proof of this simple hypothesis waits upon the production of more calves by Gamboge's Raleigh and more calves from his daughters with the notched ears. Since he is a good individual and his daughters are excellent producers, it may be possible to inbreed or linebreed to him to secure animals homozygous for this factor, but since the notched ear has little economic importance in itself, it is not likely that any expensive plan centered on securing and demonstrating such homozygous individuals will be undertaken.

The degree of expression of the factor varies in different animals. The deeper notches are always accompanied by the doubling of the sharp projection but the shallower notches do not have this and in some cases the notch is barely more than a straight line cutting off a normally curved portion of the ear. Neither is the notch always



GAMBOGE'S RALEIGH'S LEFT EAR

In all the more deeply notched ears examined the projection at the inner end of the notch was always developed into two lobes. Perhaps this is an incipient double ear. (Fig. 7.)

equally expressed in both ears of the same animal, but it is as often the right ear as the left which is most deeply notched, and often the two notches are equal, although in Gamboge's Raleigh himself, the left ear is notched somewhat more deeply. In two individuals where the notch is rather shallow in one ear, the other ear is so nearly normal that it is a matter of opinion whether a notch is really present.

An inquiry concerning the inheritance of the notch was sent to former owners of Gamboge's Raleigh, and to present owners of his calves. C. S. Gainer of Bryan, Texas, who used this bull for several years, says he does "not remember any of his calves without the notch." J. F. Houchins of Hallettsville, Texas, who used the bull for a year, says that "all his calves except one, had the mark"; also "one of the daughters has freshened and the bull calf has an 'underbit' in only the left ear." Another daughter of Gamboge's Raleigh is described by her first owner as having the mark, and by her present owner as having a normal ear "unless there is a slight straightening at the point indicated; very slight indeed. Her calf has no mark of any kind at this place." Another daughter is reported as not having the notch, and as having a heifer calf which does not have the notch. A son is reported as not having the notch, but as having one heifer calf which does have the notch. All these cases, except the last one, agree with the hypothesis already stated, when the natural human tendency to remember peculiar individuals and forget ordinary ones, is taken into account. And before the last case can be considered a very serious objection, one would want to see this son of Gamboge's Raleigh and determine surely whether the notch was really absent or only rather small.

OTHER INTERESTING PHASES OF THE CASE

This character illustrates how easily the old ideas of quantitative inheritance might arise, particularly of a character diminishing in intensity rather uniformly as one traces it farther from the foundation animal. In this case, there is a rather clear line between notched and normal animals, but there are various degrees of notching and few of his calves are as deeply notched as Gamboge's Raleigh, himself. One may speculate as to whether this is due to chance, or whether the other hereditary factors of Gamboge's

THE RIGHT EAR OF A DAUGHTER OF GAMBOGE'S RALEIGH

This characteristic appears both in male and in female descendants, so that it is not sex-linked, for if it were it would either not appear in the progeny at all, or appear only in the daughters. (Fig. 8.)

LEFT EAR OF THE HEIFER WHOSE RIGHT EAR IS SHOWN ABOVE

There is no intrinsic value in these notched ears, but it is possible that such factors may be linked with those of economic value, so that their study is important in the breeding of improved strains of livestock. (Fig. 9.)

Raleigh are so grouped as to be unusually favorable to the expression of the notch factor. Most of his calves are either purebred Jerseys or out of grade Jersey dams, but one of those mentioned by Mr. Houchins was out of a cow that had no Jersey blood, and yet the calf showed the notch, indication that the character is not dependent upon a purely Jersey complex of factors.

A CALF WITH SLIGHTLY NOTCHED EARS (Fig. 10.)

A CALF WITH DEEPLY NOTCHED EARS

There is considerable variation in the size of the notches, but the division between notched ears and normal ones is quite distinct. Very few of his descendants have ears as deeply notched as Gamboge's Raleigh. (Fig. 11.)

Two pairs of twins are included in the list of offspring personally examined. The younger pair (shown in the pictures) gives every indication of being identical twins. Not only are they both heifers and both possessed of moderate notches in their ears, but their noses, tongues, switches, and shade of general body color, are the same and they have each a single white spot on the right hind foot. This, although but a single case, is worthy of mention in view of Gowen's conclusion

TWIN DAUGHTERS OF GAMBOGE'S RALEIGH

These heifers both have moderately notched ears. They appear to be identical twins, as they are alike in all other respects as well. Identical twins are developed from a single fertilized egg cell. Some investigators have concluded on statistical grounds that identical twins do not occur in cattle, so that this case is of interest in disproving such a theory. (Fig. 12.)

reached from a statistical study[3] that few or no identical twins are produced in cattle.

There is no intrinsic economic value in this notch just as there is none in the peculiar color markings of different breeds, but it is possible that other factors economically important, but difficult and expensive to trace, such as the factors for high milk and fat production, may be linked quite closely to the factor for the notch. The fact that the first daughters of Gamboge's Raleigh are showing up well at the pail will give an opportunity of seeking for linkage when more of them have begun production. Of course, the chances are against finding such linkage, since there are nineteen pairs of chromosomes in cattle,[4] but if enough of these non-economic characters are investigated, a few will ultimately be found which will serve as guides to the inheritance of the more important ones.

Finally, as we learn one by one in our breeds of livestock, of additional characters that are transmitted like those of Drosophila and other laboratory animals, the idea will be dispelled that domestic animals are a law unto themselves, untouched by the knowledge gained from the study of insects and rodents in genetics laboratories. When as many cattle as Drosophila shall have been examined carefully, it is not unreasonable to expect that as many hereditary factors will be discovered in them. A knowledge of the relations of large numbers of hereditary factors will ultimately offer a broader control of livestock breeding than a specific knowledge of the transmission of a few, irrespective of any practical value of the latter at present. Progress in livestock breeding in the near future will depend as much on the study of all classes of characters, regardless of whether they are economic or non-economic, as on an intensive study concentrated on one or two particularly valuable traits.

[3] Gowen, John W. 1922, "Identical Twins in Cattle?" Biol. Bull. Vol. 42, No. 1.

[4] Wodsedalek, J. E., 1920, "Studies on the Cells of Cattle with Especial Reference to Spermatogenesis, Oogonia and Sex-Determination." Biol. Bull. Vol. 38, No. 5.

MATRIMONIAL VIEWS OF UNIVERSITY STUDENTS

HARRISON R. HUNT
University of Mississippi

THE presence of a substantial percentage of intellectually superior people, such as statesmen, scientists, captains of industry, clergymen, etc., is doubtless essential to the progress and prosperity of any race. Psychological and eugenical evidence indicates that intellectual capacity is inherited, and that environment merely furnishes the opportunity for the unfolding of innate mental powers. The future progress of a race, therefore, depends to a very large extent upon the rate of reproduction among its mentally superior individuals as compared with this rate among the mediocre or inferior. If, with the increase in numbers, there is either a relative or absolute decrease of able people, the race must suffer from lack of the adequate leadership which only such persons can provide.

It appears highly probable that the inborn mentality of college and university students is on the average higher than that of the population at large. This view is supported by the results of the mental tests in the United States Army during the late war.[1] The studies of Johnson and Stutzman,[2] Phillips,[3] Banker,[4] etc., show a surprisingly low birth rate among university and college graduates. An excellent review of these facts may be found in Popenoe and Johnson's Applied Eugenics.[5] The situation is far from encouraging to one who is interested in human progress.

MATRIMONIAL IDEAS OF PRESENT COLLEGE STUDENTS

Current investigations on the birth rate among college alumni must be confined to persons who graduated not less than twenty years ago, for assuming that man and wife are usually about the same age, alumni of a later date, if married, may yet have children. Consequently from such data one is unable to pass accurate judgment on the eugenic or dysgenic influences which have been operative in recent years. The writer believes it is important to discover what the college student of *today* thinks about matrimony and the family, for the ideas of intelligent young men and women influence their future conduct.

It is doubtful whether sufficient information of this kind could be obtained by personal conferences with students; they would probably hesitate to express themselves freely on all the questions asked. The temptation to make facetious answers must also be eliminated, as far as possible. Written questionnaires, to be returned to the investigator unsigned, constitute the best means of obtaining such data.

In April 1920 the writer mailed a matrimonial questionnaire to each one of the five hundred and fifty-five students then registered in the University of Mississippi. One set of questions was sent to the men, another to the women. Both questionnaires are reproduced below. Each

[1] *Proceedings of the National Academy of Science*, vol. XV.
[2] Johnson, R. H., and Stutzman, Bertha: "Wellesley's Birth Rate." *Journal of Heredity*, vol. VI, pp. 250-253, 1915.
[3] Phillips, John C. "Harvard and Yale Birth Rates." *Harvard Graduate's Magazine*, vol. XXV, no. 97, pp. 25-34, Sept. 1916. Also, *Journal of Heredity*, vol. 7, pp. 565-569, 1916.
[4] Banker, H. J. "Coeducation and Eugenics." *Journal of Heredity*, vol. 8, pp. 208-214, 1917.
[5] The Macmillan Co., New York, 1918.

student replied under oath (note the pledge at the top of the blank) and returned the questionnaire by mail, *unsigned*. Each one was thus free to express his or her inmost convictions without fear or embarrassment. By means of lectures on eugenics to the University classes in biology, which included nearly one-fifth of all the students, and a short article in the University weekly paper, the writer had impressed the student body with the importance of answering the questions seriously and accurately. Thirteen of the returned papers were discarded because either the oath was not taken or there was internal evidence of insincerity. There is every reason for believing that the remaining three hundred and twenty-eight returned questionnaires were filled out seriously and truthfully.

Eighty-five blanks were mailed to the women, four hundred and seventy to the men. Sixty-three women (74.1%) and two hundred and sixty-five men (56.4%) returned properly filled out blanks.[6]

The questions were designed to determine the percentage of students who prefer to marry, the average size of family desired, the objections to marriage, and the average kind of mate wanted.

Question four in the men's questionnaire, and five in the women's, was designed to cover the last point mentioned. As explained on the questionnaire, the qualities enumerated were to be indicated in the order of preference, "1" after a trait showing that it was the one most highly valued, "2" the second in the order of preference, and so on. Doubtless several characteristics were of equal value in the minds of many students, so it is unreasonable to stress too much the average evaluation of each characteristic. Yet in a broad way the results certainly show the general trend of student opinion. The average rating of each trait is shown in Table I (women) and Table II (men).

A glance through the list of traits in the sections devoted to mate selection shows that the student's answer must be of interest to the eugenist, who is concerned with perpetuating those inheritable characteristics which make for mental and physical vigor. Some of the qualities mentioned doubtless have slight eugenic value. On the other hand, general mental ability [Galton,[7] Thorndike,[8] Woods[9]], and health [Bell[10]] are certainly inherited, while artistic, musical [Davenport],[11] and business talents probably belong in the same category. Woods' work[9] indicates that moral qualities are transmitted; hence the student's valuation of sex purity, honesty and temperance doubtless are significant eugenically. The capacity to assimilate an advanced education [Terman],[12] [Army Mental Tests], or wealth indicates the possession of inheritable mental capacities above the average.

WOMEN'S QUESTIONNAIRE

Pledge—I hereby affirm upon my honor that I will, to the best of my ability, fill out the following questionnaire, seriously and truthfully.

.....

(Place X here if you are willing to take this pledge.)

1. When circumstances permit, do you prefer to marry?.....
(Answer Yes or No.)

[6] I wish to take this opportunity to thank two of my former students in Genetics, Miss Rosa Hargis, and Miss Elizabeth Kimmons, for their faithful and painstaking assistance in recording and arranging the data derived from the questionnaires.

[7] Galton, Francis. "Inquiries into Human Faculty." London, 1907. "Heredity Genius," London, 1914.

[8] Thorndike, E. L. "Educational Psychology." Teacher's College, Columbia University, 1910.

[9] Woods, Frederick Adams. "Heredity in Royalty." New York 1906.

[10] Bell, Alexander Graham. "The Duration of Life and Conditions Associated with Longevity." Genealogical Record Office, Washington, D. C., 1918.

[11] Davenport, C. B. "Heredity in Relation to Eugenics." Henry Holt and Co., 1911.

[12] Terman, L. M. "The Measurement of Intelligence." Houghton, Mifflin Co., 1916.

2. If you do not prefer marriage, please state your objections to it.
3. If a young woman has a favorable opportunity to marry, do you think she should reject it in favor of a career? (In medicine, teaching, business, etc.)
.....
(Answer Yes or No.)
4. Underscore the number of sons and daughters which you think would constitute an ideal family:
Sons—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
Daughters—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
5. If you are favorably disposed to marriage, please fill out the table below, thus indicating the relative importance you attach to the qualities of a prospective husband. For instance, if you consider social ability the most important characteristic for a husband to have, place 1 after "social ability" in the table. If you consider disposition the next most important consideration, place 2 after "disposition," and so on through the list.

a. Personal neatness.
b. Prominence.
c. Artistic ability.
d. Good looks.
e. Natural mental ability.
f. Disposition.
g. Interest in religion.
h. Honesty.
i. Social ability.
j. Sex purity.
k. Education.
l. Willingness to rear a family.
m. Abstinence from use of tobacco.
n. Abstinence from use of liquor.
o. Abstinence from use of drugs.
p. Attitude on woman's suffrage.
q. Health.
r. Ambition.
s. Fondness for sports.
t. Family connections.
u. Business ability.
v. Mutual intellectual interests.
w. Native State or Section of country.
x. Wealth.

6. Have your views regarding matrimony changed since you entered this University?.....
If, so, what were your views previously, and why did you change them? (If you have previously attended any other college or university, indicate any change of views since coming to this University.)
7. Age.
8. School and class in University.
9. Home state or county.
10. Married.

You are not expected to sign your name to this questionnaire. Please mail the questionnaire, filled out, to H. R. Hunt, University, Miss., before April 24, 1920.

The above is the questionnaire which was mailed to the women students. Ninety-eight per cent of the women expressed their preference for married life. Seventy-four per cent of them believed that a woman should marry even if given a chance to enter upon a career. Of the sixteen women (26%) who believed that a woman should reject matrimony for a career, fifteen answered question 1 affirmatively, indicating that they were not emotionally averse to marrying. Obviously they are not "men haters." Banker, working on the data from Syracuse University, suggests that the University curriculum attracts women who, on the average, are somewhat abnormal in their sex reactions. While the evidence indicates that there may be some women of this type in the University of Mississippi, they do not at the most constitute more than a fourth of the women students, and the fact that nearly all answered the first question affirmatively strongly supports the view that they have fairly well developed domestic instincts.

Sixty women replied to question 4. The averages computed from the answers to this question are 2.1 sons and 1.9 daughters. This practically amounts to a family of four children. The minimum number of children mentioned was two and the maximum six.

Question 4 does not bluntly ask each woman how many children *she desires* to have. Such directness might have aroused an antagonism which would have kept many from answering the question at all. It seems likely, however, that the "ideal family" would be the goal toward which any woman

would strive, health and financial resources permitting.

It is gratifying to know that the childless family does not find favor among the women students of the University of Mississippi. On the contrary, their views at present will doubtless influence a large part of them to marry and become the mothers of families of several children each.

The results of question 5 are shown in Table I. The left column gives the characteristics of the prospective husband, and the column at the right shows the *average* of all the ratings for each characteristic. The answers of fifty women were sufficiently complete to be used in making this table.

TABLE I

Characteristic	*Average rating*
Sex purity	1.7
Honesty	4.5
Disposition	4.4
Health	5.6
Natural mental ability	7.3
Education	8.0
Abstinence from liquor	8.5
Abstinence from drugs	9.0
Ambition	9.2
Interest in religion	10.0
Business ability	10.3
Personal neatness	10.3
Willingness to have family	13.3
Mutual intellectual interests	13.5
Family connections	14.3
Prominence	15.6
Social ability	16.6
Good looks	16.9
Abstinence from tobacco	17.8
Artistic ability	18.5
Fondness for sports	18.6
Wealth	19.5
Native state or section	22.0
Attitude on woman suffrage	22.1

"Sex purity" receives first place with a rating of 1.7. Seventy-four per cent of the women graded this "1." The writer should have used the term "chastity" to express his intent instead of "sex purity," for it was found after the data had been tabulated that some of the women who filled out the questionnaire had in mind freedom from venereal infection rather than chastity. A woman student of mine questioned on this point thirty-two of the women who sent in the questionnaire. Eighteen of them had interpreted "sex purity" as freedom from venereal disease, fourteen took it to mean chastity. All informed her, however, that they regarded male chastity and freedom from venereal infection as being of equal importance. Doubtless chastity holds a very high place in the minds of these women, though it is impossible to assign it to a definite place in this series.

"Honesty" and "disposition" are next on the list and are of about equal rank. "Honesty" received four per cent of the "1" ratings, and "disposition" two per cent. If morality is to a large extent inheritable (Woods: See footnote 9) the high grading of "honesty" is eugenically fortunate.

"Health" and "natural mental ability" also rank high. "Health" was given six per cent of the "1" ratings, while "natural mental ability" received ten per cent of them. Both are believed to be inheritable. Consequently these ratings are eugenic.

As might be expected "education" holds a high place on the list. It is slightly above "abstinence from liquor." This is interesting in view of the fact that the latter depends partly on the former.

"Abstinence from drugs" and "ambition" are rated nearly the same.

"Interest in religion," "business ability," and "personal neatness" come next. Religious inclinations are graded distinctly below all the moral qualities. May it not be that the students regard religion and theology as synonymous?

It is unfortunate eugenically that personal neatness ranks so much higher than "willingness to have a family" or "family connections." It is far less important eugenically to keep one's trousers pressed, etc., than to bear children, if one comes of good stock. It is far more important for a young woman to scan a suitor's relatives to form an estimate of his, and his prospective children's, quality, than to be particular about his clothes. It has been suggested, however, that most of the students when rating "family connections" had in mind some of the pseudoaristocrats, of no particular eu-

genic worth, who attempt to copy the manners and life of real aristocrats.

As might be expected, "good looks" are not of paramount importance to the women.

The low place assigned to "fondness for sports" indicates that the women's judgment in mate selection has not as a rule been much influenced by the glamor of the college athlete.

"Wealth" is near the bottom of the list. The acquirement of wealth depends as a rule upon the possession of more than average ability. Assuming that wealthy men usually marry into good stock, their sons should usually be above the average in ability, and therefore desirable mates eugenically. For these reasons it is unfortunate that the possession of wealth is held in such low esteem by these fifty young women.

A small minority (13%) have changed the views on marriage since entering the University. Almost all of these said that they had come to want a higher type of husband, or to regard matrimony more seriously in one way or another since entering the University.

The above facts show that the young women in the University of Mississippi certainly have on the whole sound ideas, socially and eugenically, on the question of matrimony.

MEN'S QUESTIONNAIRE

Pledge. I hereby affirm upon my honor that I will, to the best of my ability, fill out the following questionnaire seriously and truthfully.....
(Place X here if you are willing to take this oath.)

1. When circumstances permit, do you intend to marry?.....
(Answer Yes or No.)

2. If you do not intend to marry, please frankly state your objections to matrimony.

3. Underscore the number of sons and daughters which you think would constitute an ideal family:
Sons—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
Daughters—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

4. If you contemplate marriage, please fill out the table below, thus indicating the relative importance you would attach to the several qualities of a prospective wife. For instance, if you consider social ability the most important characteristic for a wife to have, place "1" after "social ability." If you consider disposition the next most important consideration, place "2" after it, and so on through the list.

a. Housekeeping ability.
b. Artistic or musical ability.
c. Education.
d. Natural mental ability.
e. Disposition.
f. Interest in religion.
g. Moral character.
h. Willingness to rear a family.
i. Beauty.
j. Social ability.
k. Health.
l. Fondness for sports.
m. Ambition.
n. Family connections.
o. Business ability.
p. Wealth.
q. Mutual intellectual interests.
r. Native state or section of country.
s. Attitude on woman's suffrage.

5. Have your views concerning the desirability of matrimony changed since you entered the University?....
If so, what were your views previously? Why did you change them? (If you have previously attended any other college or university, indicate any change of views since coming to this University.)

6. Age.
7. School and class in University.
8. Home state and county.
9. Married?

You are not expected to sign your name to this questionnaire. Please mail the questionnaire, filled out, to H. R. Hunt, University, Miss., before April 24, 1920.

Ninety-eight per cent of the men said that they intended to marry. The average of all the answers to question 3 (referring to the composition of the ideal family) is 2.5 sons and 1.8 daughters—in round numbers a family of four children. The range of choice is from none (one case) to ten children. Evidently the University men, like the

women, are opposed to childless families.

Table II is a tabular digest of the replies to division 4 of the men's questionnaire.

TABLE II

Characteristic	*Average for all men*
Moral character	1.9
Health	3.8
Disposition	3.9
Education	5.5
Natural mental ability	6.4
Willingness to rear family	8.0
Interest in religion	8.4
Housekeeping ability	8.7
Beauty	8.9
Ambition	10.1
Social ability	10.4
Family connections	11.3
Artistic or musical ability	11.5
Mutual intellectual interests	12.7
Business ability	12.9
Wealth	14.2
Fondness for sports	14.3
State or section	17.0
Attitude on woman suffrage	17.7

The table gives the average ratings for each of the characteristics. It was compiled from the answers of two hundred and forty-four men from all departments and years of study in the University.

"Moral character" easily heads the list in this column. It is unfortunate that this point was not subdivided into chastity, honesty, etc., yet chastity was no doubt the trait that most of the men had in mind in grading this point. The high rating of morality is fortunate eugenically, as previously indicated.

"Health" and "disposition" come next, and are rated about the same. This emphasis on health is eugenically desirable, as mentioned before.

Next comes "education," then "natural mental ability." A person can not proceed far with the first without the second. Natural talent is ranked high, as it should be in any eugenic scheme.

"Willingness to rear a family," "interest in religion," "housekeeping ability," and "beauty" follow in the order named. The fact that religious interests are separated so clearly from moral character indicates that the men students had the theological aspects of religion in mind, for the most part, in rating this point. The fact that physical attractiveness in a woman is so distinctly subordinated to her morality, health, education, and intelligence, shows that the University men are influenced in their matrimonial ideas more by their intelligence than by their sex passions.

The comparatively low rating of "social ability" shows that a "social butterfly" is not particularly desired.

It seems to the writer that "wealth" and "family connections" should not have been ranked below "social ability." As a rule wealthy women probably come from families of superior mentality, for the acquirement of money doubtless depends to a large extent on inheritable mental abilities. A woman's membership in a "good family" should favor the development of desirable traits in her children. But possibly here too the existence of many innately mediocre families who strive to imitate genuine aristocrats has led the University student to regard family connections as unworthy of serious consideration.

Table III is a comparison between the data of Tables I and II. The left column shows the order of characteristics as arranged by the men, with those traits omitted which were not in the women's questionnaire. Similarly the right column shows the traits as arranged by the women, with those characteristics left out which were not inserted in the men's questionnaire. This treatment makes it possible to compare the women's average ideal of a mate with the men's. In the women's column "sex purity" and "honesty" have been combined in one and considered equivalent to "moral character."

The men and women practically agree on the high ranking of morality, health, disposition, education, and native mental ability. In short, they agree on the social and eugenic fundamentals. The men rate the willingness to have a family and physical attractiveness significantly higher than do

the women. This is, of course, what would have been expected. Conversely the women rate the following traits significantly higher than the men do: ambition, business ability, and mutual intellectual interests. As would be expected, the women emphasize more than the men the importance of business sagacity and the determination to succeed. "Interest in religion" is rated the same by both sexes.

TABLE III

Men's Questionnaire	Women's Questionnaire
Moral character	Moral character (sex purity and honesty)
Health	Disposition
Disposition	Health
Education	Natural mental ability
Natural mental ability	Education
Willingness to rear family	Ambition
Interest in religion	Interest in religion
Beauty	Business ability
Ambition	Willingness to have family
Social ability	Mutual intellectual interests
Family connections	Family connections
Artistic or musical ability	Social ability
Mutual intellectual interests	Good looks
Business ability	Artistic ability
Wealth	Fondness for sports
Fondness for sports	Wealth
State or section	State or section
Attitude on woman's suffrage	Attitude on woman's suffrage

There are other slight, though not very significant, points of agreement and divergence between the ideals of the two sexes. The results of this comparison agree well with general experience. This agreement greatly strengthens the belief that the students were conscientious in filling out their questionnaires.

Two hundred and nineteen men answered question 5. Thirty-five (16%) of these stated that their views regarding the desirability of matrimony had changed since entering the University. The replies of only five (2.3% of the whole) indicated that the change had been for the worse, judged by conventional standards. In eleven cases it was difficult to decide whether the change in views had been beneficial or harmful. The majority, nineteen, had changed for the better. These results certainly indicate a wholesome moral atmosphere in the University of Mississippi.

In criticising the student's ideas on mate selection the writer does not wish to imply that the desirability of a mate depends entirely upon his or her worth from the standpoint of heredity. Manners, physical attractiveness, temperament, and other characteristics that stimulate the emotions of others

have an important place. But young people should be induced to form those sentimental attachments that will lead to racial betterment rather than deterioration.

The importance of environment in providing the fertile soil in which the seeds of hereditary promise may grow, should not be minimized. But the prevalence in democracies like ours of the fallacious dogma of human equality makes it imperative to emphasize the fundamental importance of heredity.

SUMMARY

It is impossible to say to what extent the views of these students will affect their future conduct with reference to matrimony, but undoubtedly there will be an effect.

For the most part the attitude of the students in the University of Mississippi is morally and eugenically good. Almost all the men and about three-quarters of the women intend to marry, if circumstances permit. The average size of family preferred is four children. This number is sufficient to replace this group in the next generation. The relative rating of those traits which are usually considered in choosing a husband or wife are morally, and for the most part eugenically, sound. Doubtless the questionnaires were filled out by the better class of students, since one would naturally suppose that such students would be most likely to take an interest in an investigation of this kind. If this assumption is correct, these findings are particularly gratifying. As far as can be determined the changes in attitude toward matrimony have been mostly for the better, showing that the moral atmosphere of the University is good.

A German Statement of Eugenics

GRUNDRISS DER MENSCHLICHEN ERBLICHKEITSLEHRE UND RASSENHYGIENE, BAND II: MENSCHLICHE AUSLESE UND RASSENHYGIENE, von Dr. Fritz Lenz, privatdozent für hygiene an der Universität München, pp. 251, preis des I u. II Bandes in 1 Band gebunden, $2.60; München, J. F. Lehmanns Verlag, 1921.

One of the encouraging facts about the science of eugenics is that it has now become somewhat stabilized. Take the presentation of the leaders of the movement in the United States, England, France, and Germany, for instance, and there will be found to be remarkably little divergence among them, on fundamental questions of eugenic policy. The present book, which is quite the best I have seen from the Continent, gives a sound and conservative account of natural and artificial selection in man, of "social race hygiene" and of "private race hygiene." Although it is not well documented, it will be of great interest to all in the United States who are concerned with the eugenics movement. In Germany it has already gone into a second edition.—P.P.

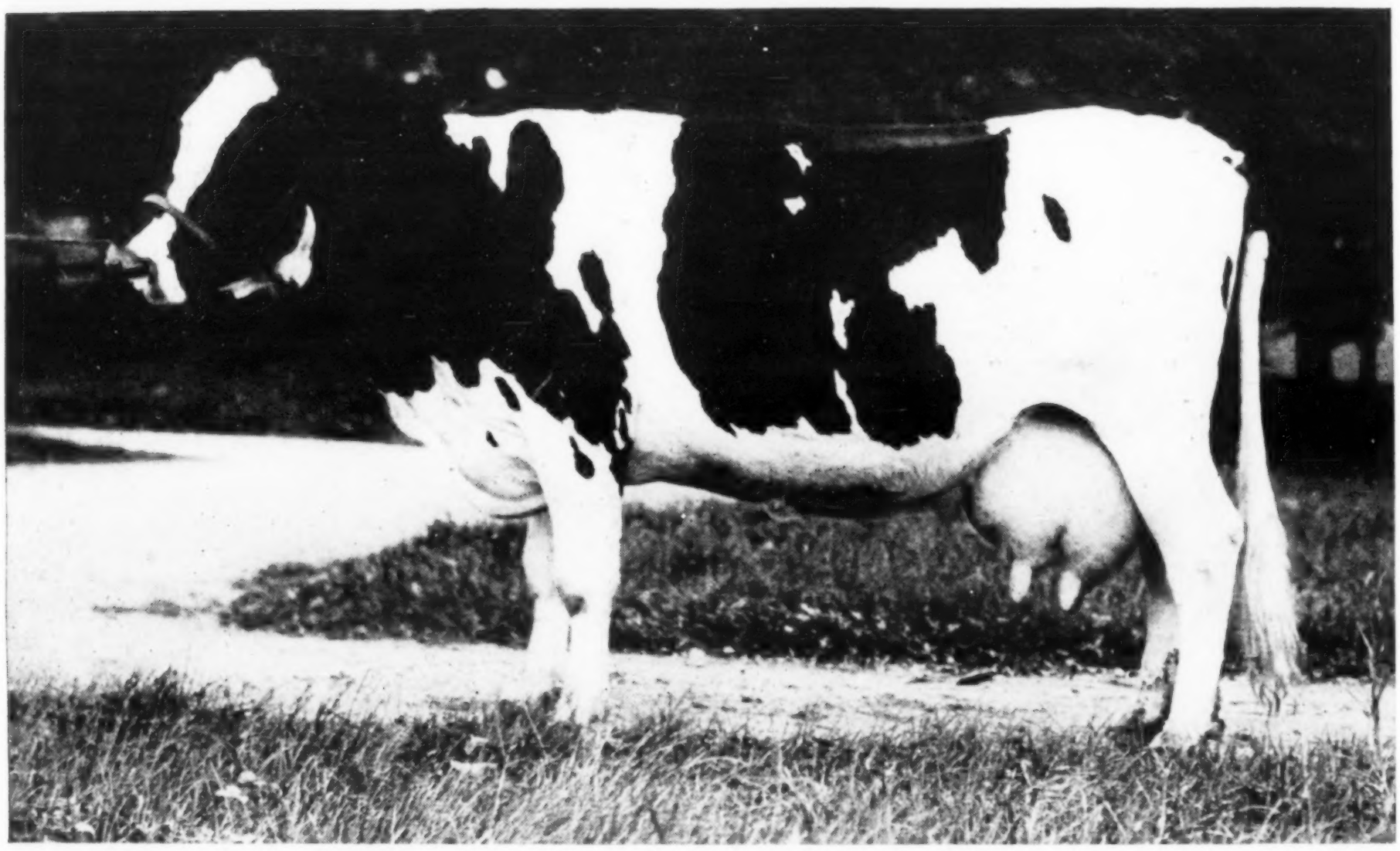
Biology and Religion

THE DIRECTION OF HUMAN EVOLUTION, by Edwin Grant Conklin, professor of biology in Princeton University. Pp. 247, price $2.50. New York, Charles Scribner's Sons, 1921.

This series of lectures, delivered on a foundation calling for discussion of the mutual bearings of science and religion, will give the reader who has little acquaintance with biology a good idea of some of the broader fundamental concepts. Its widespread perusal should help to make for a better understanding of the application of the doctrine of evolution to many important problems of human philosophy and politics.—P.P.

A CASE OF TWINNING IN DAIRY CATTLE

C. C. HAYDEN
Ohio Agricultural Experiment Station, Wooster



GRACE DARLING HENGERVELD 242862, DAM OF FIVE SETS OF TWINS AND TWO SINGLES (Fig. 13.)

GRACE DARLING HENGERVELD, 242862, a purebred Holstein-Friesian cow, known as No. 90 (Fig. 13) in the Ohio Agricultural Experiment Station herd, has conceived twins five times out of seven.

Grace belongs to a prolific family. Her granddam (No. 57) is now 14 years old and calved the 11th time, November 21; 65 calves have been born in the herd from her and her female progeny. Four females which might have produced additional progeny by this date were sold, and two died. Had the four not been sold, 10 more might have been added. Of the progeny, 31 were females and 34 were males.

The great-granddam (No. 33) of Grace Darling Hengerveld was bred to a son of Sarcastic Lad, and produced No. 57. She was again bred to the same sire and produced twins—male and freemartin.

No. 57 was bred to her sire and produced No. 70, and later a set of twins—male and freemartin. Bred to Marcella Hengerveld De Kol, she produced No. 107, who gave birth to one set of twins—male and freemartin.

No. 70 gave birth to nine calves including No. 90 (the cow mentioned above) who has calved as follows:

1st, No. 124 by her own sire, Marcella Heng. De Kol 70519.

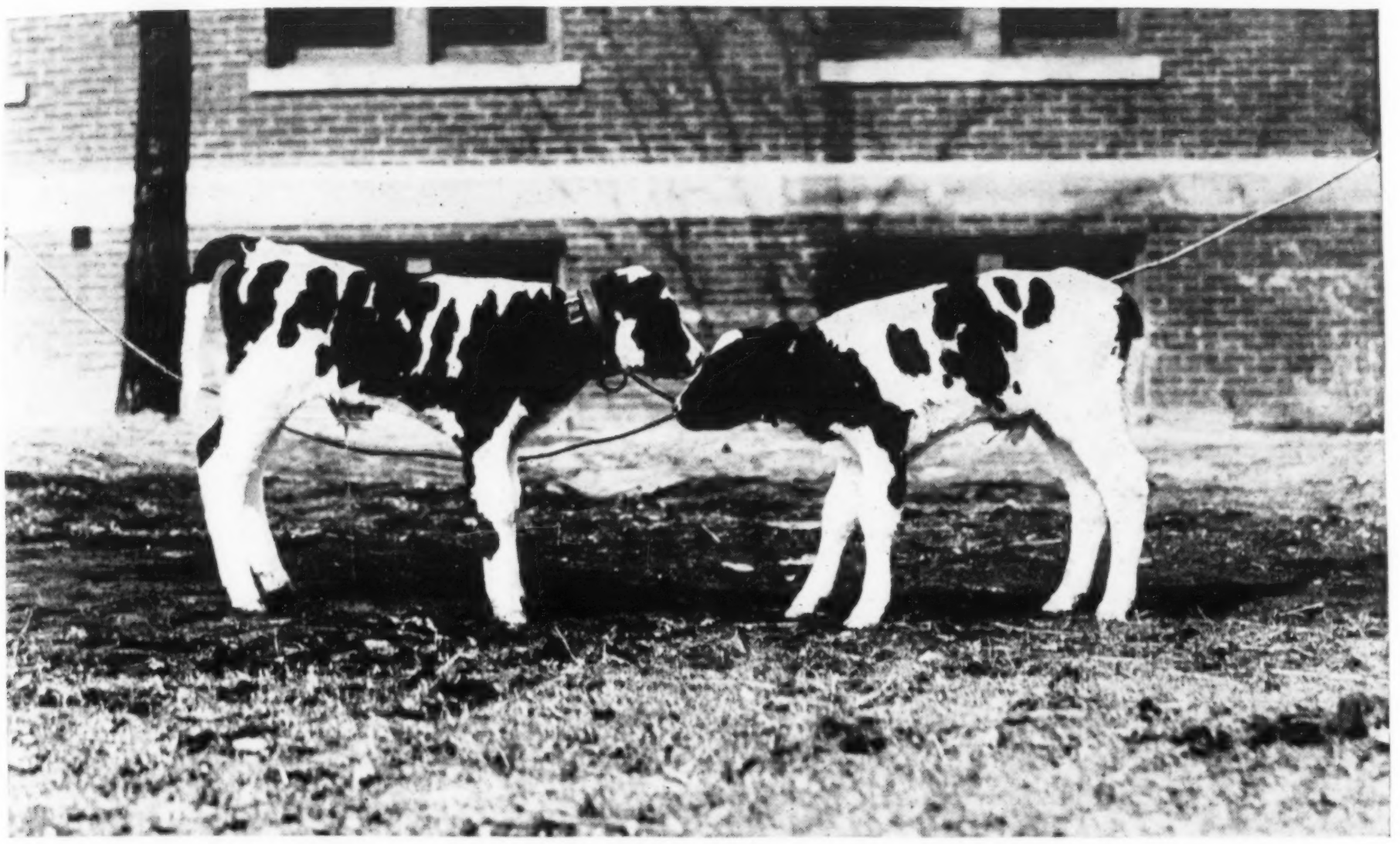
2d, twins, males, by her own sire Marcella Heng. De Kol 70519.

3d, No. 163, by her own sire, Marcella Heng. De Kol 70519.

4th, twins, males, (aborted) by King Pontiac De Kol Spr. Brook 150875.

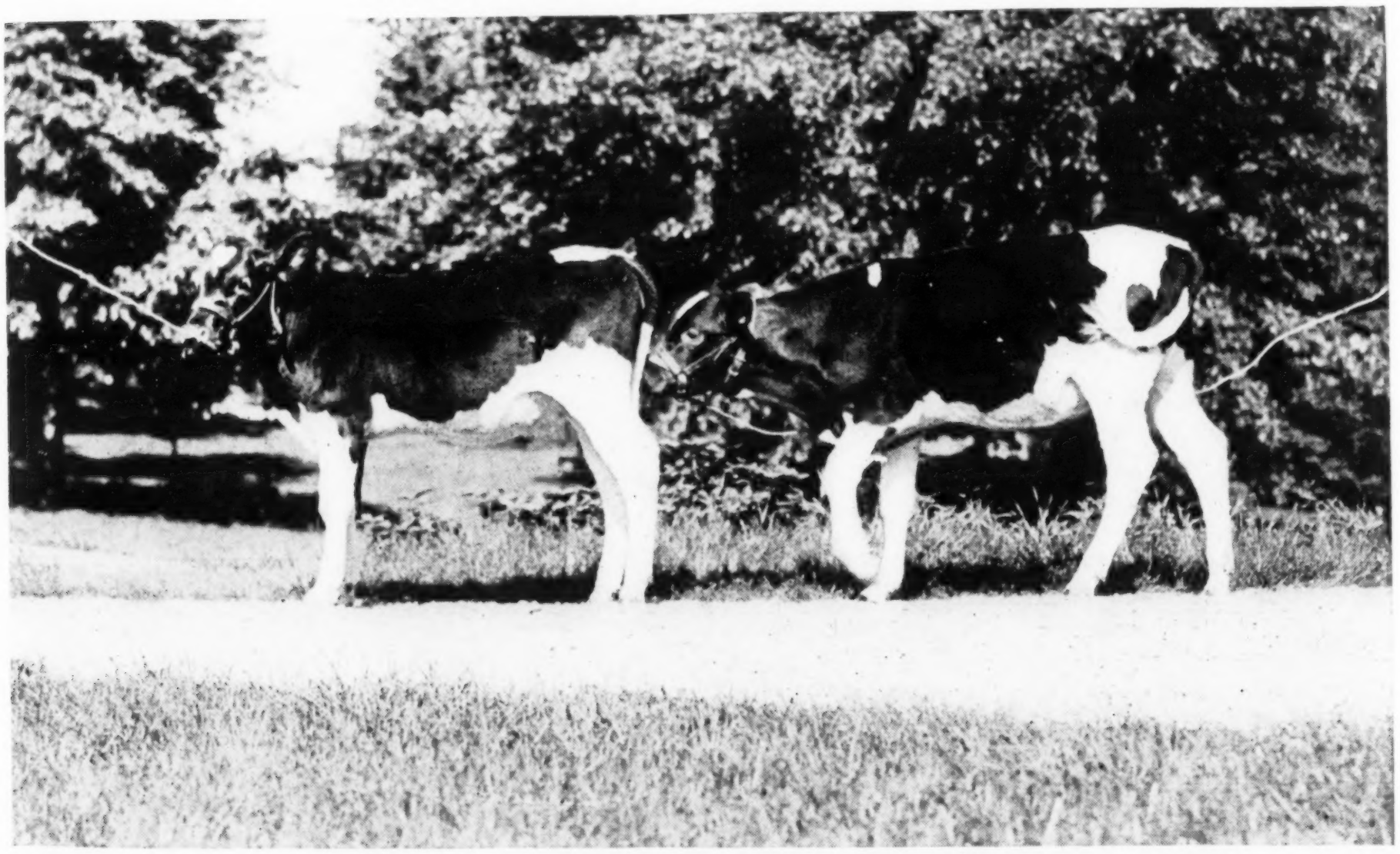
5th, twins, male and freemartin, by same bull.

6th, twins, male and freemartin, by same bull.



GRACE DARLING HENGERVELD'S FIRST TWINS

They were by her own sire; born Mar. 10, 1915. Photo taken at two days of age (Fig. 14.)

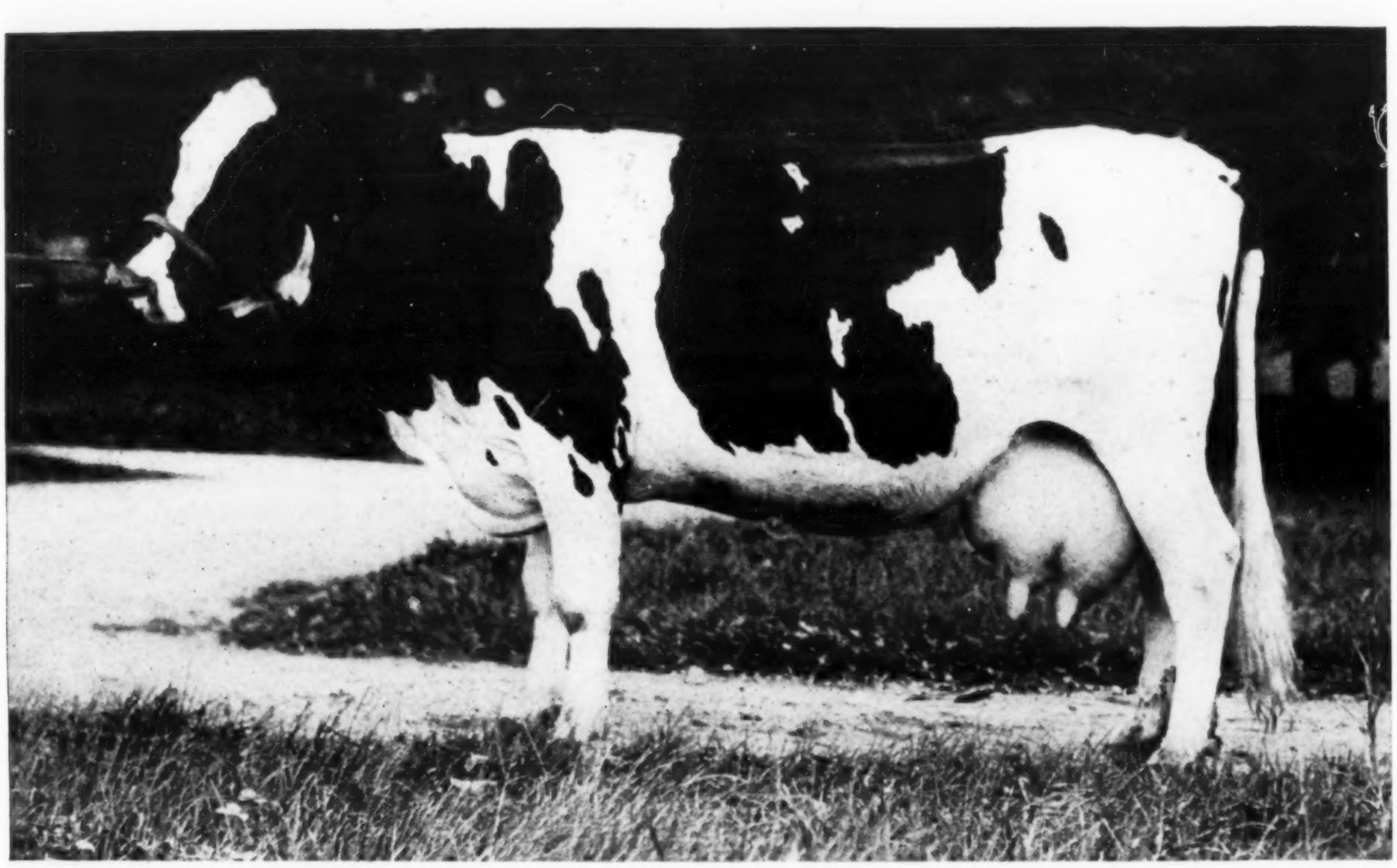


GRACE DARLING HENGERVELD'S TWINS SIRED BY K. P. DE KOL SPRING BROOK

Born Mar. 10, 1919. Photo taken at three months of age (Fig. 15.)

A CASE OF TWINNING IN DAIRY CATTLE

C. C. HAYDEN
Ohio Agricultural Experiment Station, Wooster



GRACE DARLING HENGERVELD 242862, DAM OF FIVE SETS OF TWINS AND TWO SINGLES (Fig. 13.)

GRACE DARLING HENGERVELD, 242862, a purebred Holstein-Friesian cow, known as No. 90 (Fig. 13) in the Ohio Agricultural Experiment Station herd, has conceived twins five times out of seven.

Grace belongs to a prolific family. Her granddam (No. 57) is now 14 years old and calved the 11th time, November 21; 65 calves have been born in the herd from her and her female progeny. Four females which might have produced additional progeny by this date were sold, and two died. Had the four not been sold, 10 more might have been added. Of the progeny, 31 were females and 34 were males.

The great-granddam (No. 33) of Grace Darling Hengerveld was bred to a son of Sarcastic Lad, and produced No. 57. She was again bred to the same sire and produced twins—male and freemartin.

No. 57 was bred to her sire and produced No. 70, and later a set of twins—male and freemartin. Bred to Marcella Hengerveld De Kol, she produced No. 107, who gave birth to one set of twins—male and freemartin.

No. 70 gave birth to nine calves including No. 90 (the cow mentioned above) who has calved as follows:

1st, No. 124 by her own sire, Marcella Heng. De Kol 70519.

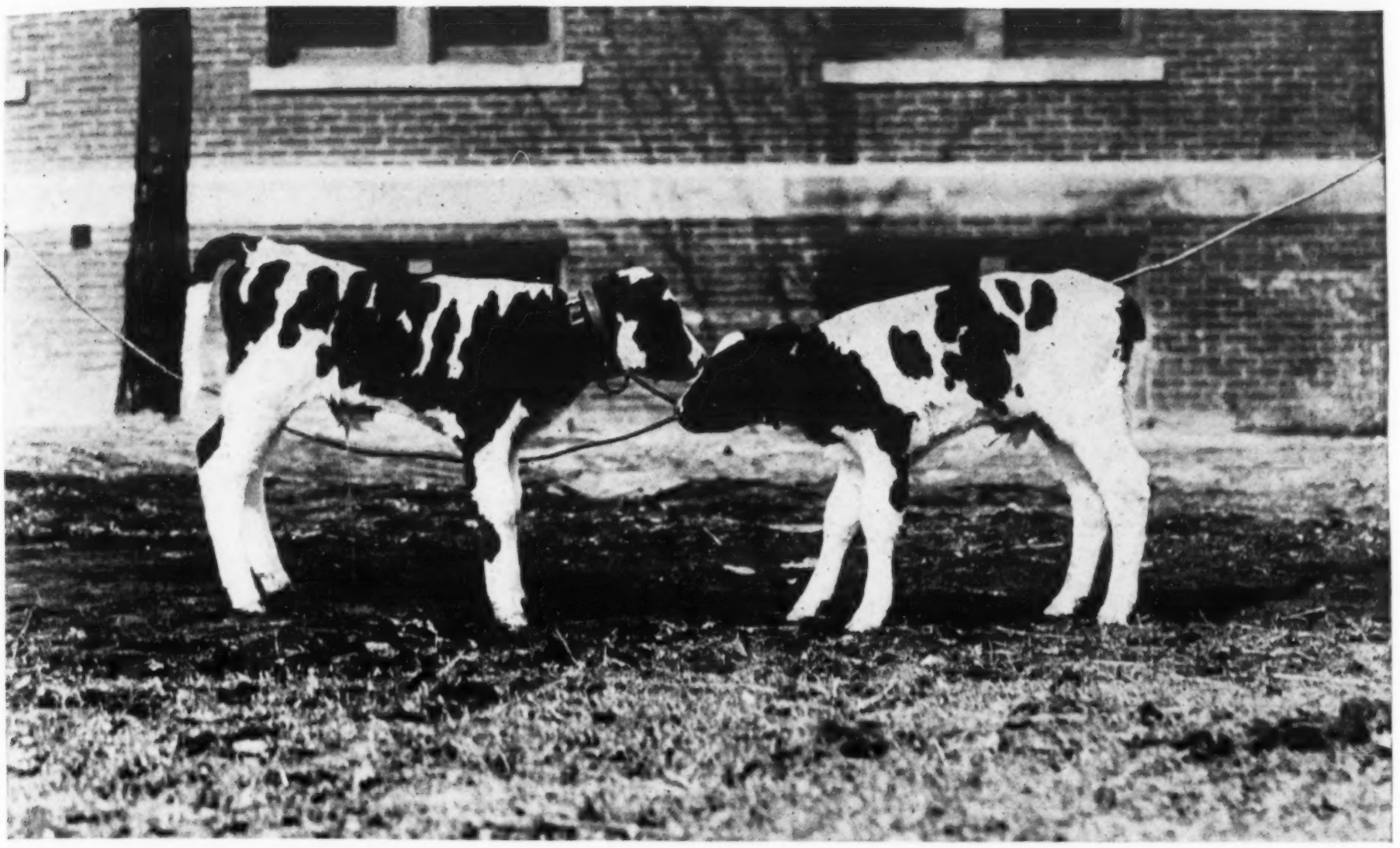
2d, twins, males, by her own sire Marcella Heng. De Kol 70519.

3d, No. 163, by her own sire, Marcella Heng. De Kol 70519.

4th, twins, males, (aborted) by King Pontiac De Kol Spr. Brook 150875.

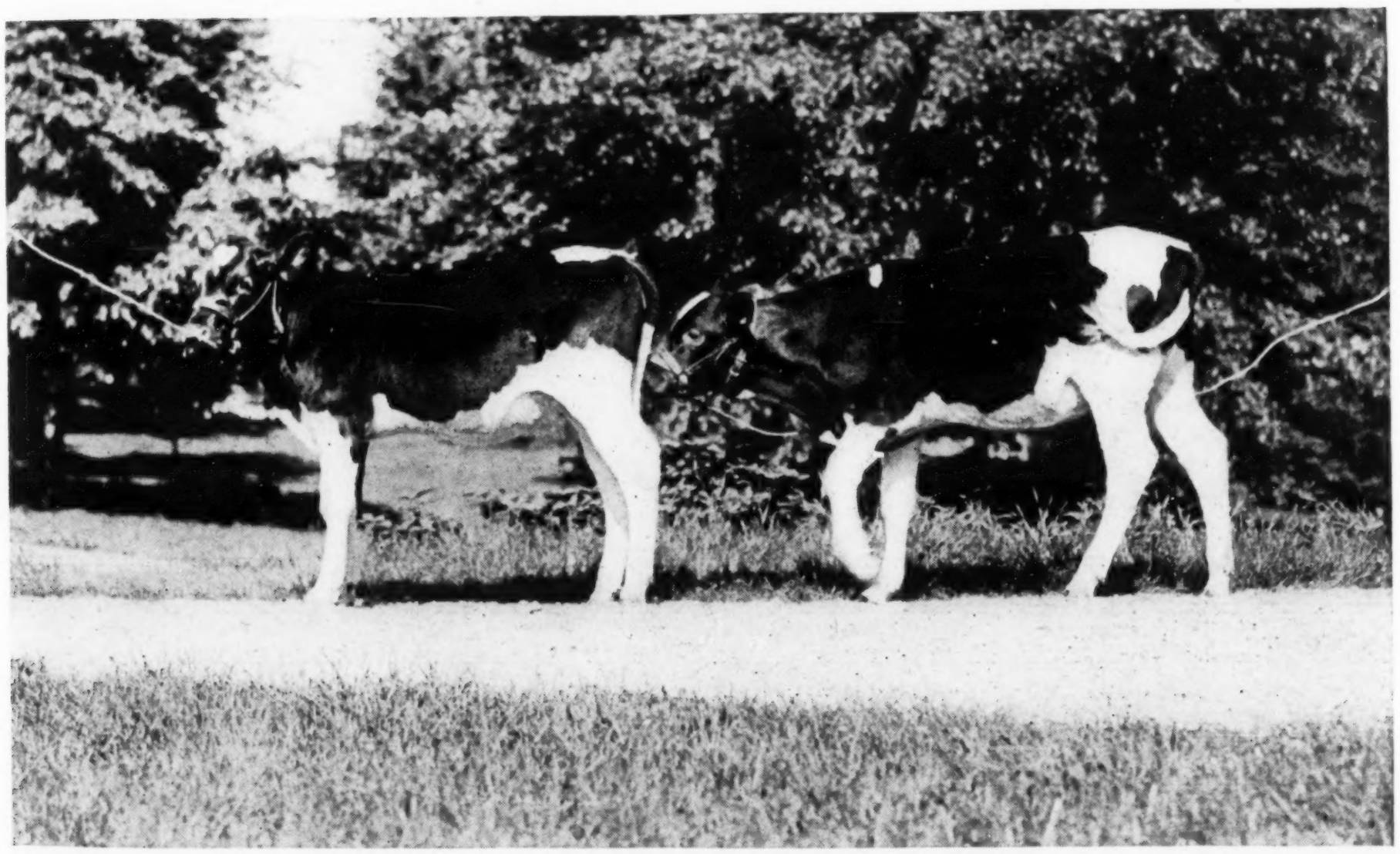
5th, twins, male and freemartin, by same bull.

6th, twins, male and freemartin, by same bull.



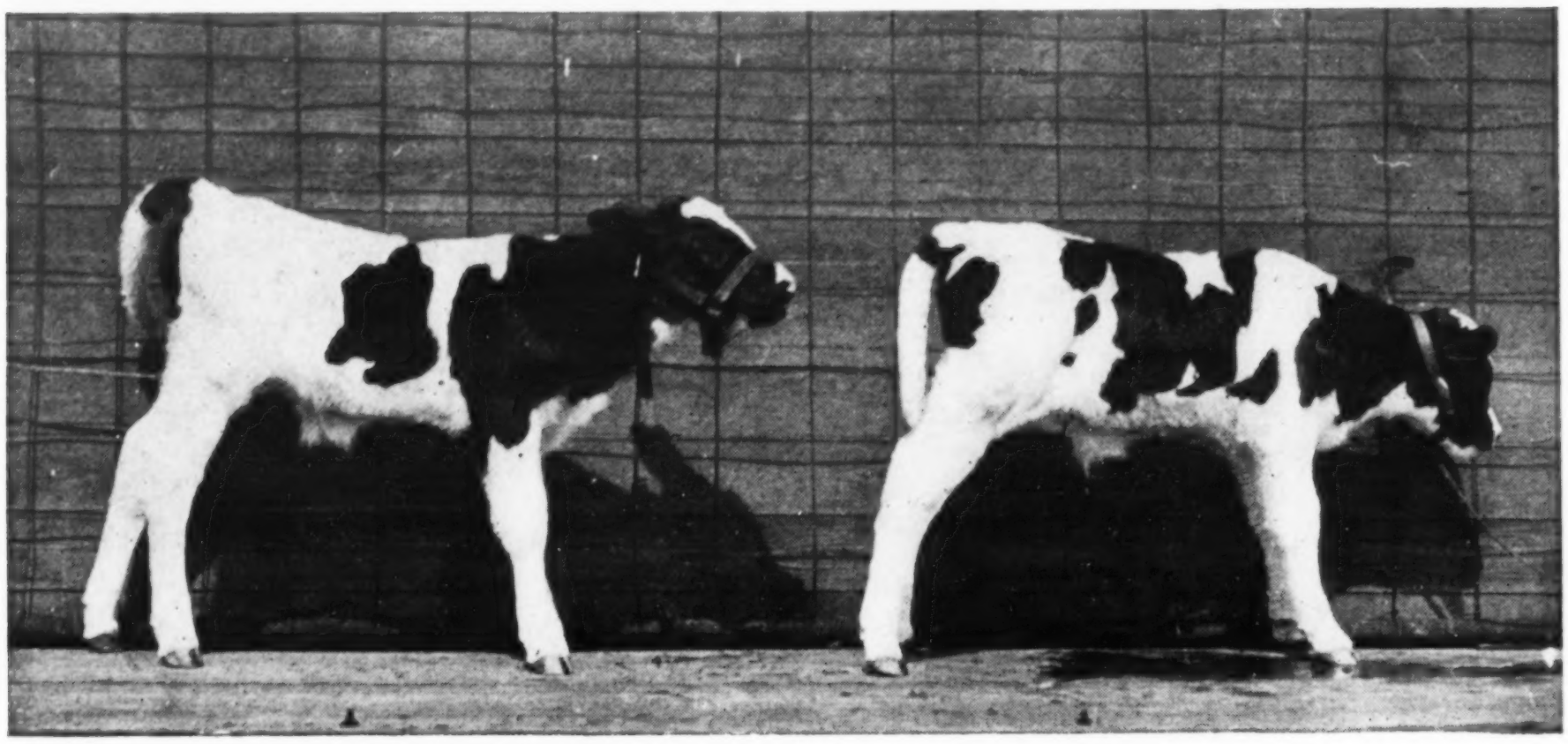
GRACE DARLING HENGERVELD'S FIRST TWINS

They were by her own sire; born Mar. 10, 1915. Photo taken at two days of age (Fig. 14.)



GRACE DARLING HENGERVELD'S TWINS SIRED BY K. P. DE KOL SPRING BROOK

Born Mar. 10, 1919. Photo taken at three months of age (Fig. 15.)



GRACE'S LAST TWINS BY MEADOW HOLM JENNIE KING
Born Mar. 29, 1921. Photo taken at six days of age (Fig. 16.)

7th, twins, males, by Meadow Holm Jennie King, 218701.

Note that she has twinned to service by three bulls.

It has been suggested that one might develop a family of cows which would produce a high percentage of twins; but of the nine sets of twins in this family, six sets were male and freemartin and three sets were males. Was it mere chance that there was no set of females? Three of the freemartins were kept until of breeding age. Only one came in heat and was bred, but failed to conceive. An exanination of the vagina showed it to be abnormal.

The cows in this family are good producers as well as reproducers:

The highest record of No. 57 was 21,177 lbs. milk, 888 lbs. 80% butter.

The highest record of No. 70 was 17,492 lbs. milk, 740 lbs. 80% butter.

The highest record of No. 107 was 22,161 lbs. milk, 940 lbs. 80% butter.

The highest record of No. 124 was 20,377 lbs. milk, 953 lbs. 80% butter.

No. 90's entire milk and butter record is as follows:

Period	*lbs. milk*	*lbs. 80% butter*	*Days in milk*
1st.....	9,634	455	360
2d.....	13,147	643	388
3d.....	19,966	953	500
4th.....	12,971	591	362
5th.....	21,528	1023	658
6th.....	(incomplete)		

She is now nine years old and producing well during her 6th lactation period. She has never been officially or semi-officially tested for advanced registry.

The calves produced by these cows, of which 30 were males, and 23 were females and freemartins, were as follows:

Cow	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
No. 33	?	M	M	F	F	F	?	M&F			
No. 57	F	M	M	F	F	M	M	M&F	F	F	M
No. 70	F	F	M	M	M	F	M	M	M		
No. 107	M	F	F	M&F	M	F					
No. 90	F	M&M	F	M&M	M&F	M&F	M&M				
No. 124	M	M	M&F	F	M						

THE TEMPERATURE OF THE MELTING POT[1]

(A Review)

THERE is a general belief that the melting pot is not functioning in the United States and that the immigrant races largely remain foreigners. Dr. Pearl assumes the contrary position and shows by an analysis of the birth records for a large part of the United States, including our large foreign settlements, that hybridization and race fusion are going on apace and that a new race is being evolved here in America that within the next two centuries will have supplanted completely the relatively pure racial stocks from Europe.

"Science tries ever to peer into the future, and nowhere is the desire to estimate what the future has in store stronger than in the case of matters relating directly to human actions, emotions and thoughts. This general interest of man in his future social, physical and mental evolution crystallizes in a specific way for us here and now in the problem of the future American civilization. Our gates have been open, with some slight and on the whole insignificant exceptions, to all and sundry. Good, bad, and indifferent people have been free to settle here, and have made the fullest use of the freedom. The problem is to determine to what extent racial amalgamation or fusion occurs." Dr. Pearl has attempted with the limited data available to gain an insight into this problem and in the course of a statistical analysis has uncovered some important and hitherto unsuspected facts.

An analysis of the growth of a population in an area of fixed limits leads to the prediction that, "strange and inconceivable as it may appear to many persons, the United States is going to be sometime a densely crowded country where each individual, consciously or unconsciously, will be challenging the right of every other individual to existence. And further, the time when this pressure of population will be felt definitely in this country is not far away and by every present indication in less than two centuries we may expect a degree of pressure of population upon means of subsistence which will make the everyday life of everybody a different thing entirely from the prodigally wasteful business it now is. We shall be uncomfortably close to the limit of population by 2100 at a time which the great grandchildren of a number of persons now living will be components of the population. What *kind* of a population will that be? What elements now in the population will then, and in the succeeding years, be the dominant ones? Or, will none of the racial groups now so distinct in our population exist as such then, having in the meantime fused and amalgamated, one with the other, till there remains only a biologically homogeneous whole? These questions cannot be answered positively today but present *tendencies* and past experience can be examined."

"The United States has been, from its beginning a gigantic experiment in human genetics." The degree to which the admittedly large mass of immigrants who have found their way to our shores is being absorbed by the native population and fused into a new race has been a matter of much speculation both in and out of print. Very little definite information has been available due chiefly to the lack of funds for compiling existing data and to the failure to collect some of the much needed information.

"Vast quantities of ink have been spilled in the discussion of the 'melting pot' in America. It would be unbelieveable if it were not true, in view of the

[1] Review of an article "The Vitality of the Peoples of America" by Dr. Raymond Pearl, Amer. Jour. of Hygiene, Vol. I., Nos. 5 and 6, Sep.-Nov., 1921.

interest in this subject, and its obvious importance as a factor in national well-being, that no data are available by which the degree or extent of the 'melting' or racial fusion can be measured on a national scale."

In spite of the lack of accurate information or probably because of it there is a general belief that the immigrants are not being absorbed and are remaining, in restricted colonies, essentially foreigners. Pearl's analysis of the Census data for the Birth Registration Area leads him to the opposite conclusion. "That newly arrived foreigners rather speedily fuse effectively with the stocks already here, to a degree much greater than is presupposed, at least in most popular discussions of the subject of immigration and related matters."

"For the entire Birth Registration Area the percentage of amalgamation or fusion of foreign-born stocks with native-born as compared with racially like effective matings of all sorts is just under 11.5 per cent. That is, for about every ten effective marriages in which the partners were of like nativity there was one in which one partner was of American and the other of foreign nativity. On the whole this appears a reasonably large proportion, when one considers inherent prejudices which must be overcome before such marriages can occur. Of course one realizes fully that some unknown, but certainly significant proportion of this American × foreign-born cross matings really are not racially cross at all but like, one partner merely having been born in the United States. But fully granting this, there are two further points to be noted, namely: first, that American birth and upbringing to marrying age tend to create a considerable measure of antipathy or prejudice towards the more recent immigrants of the same race. In making this statement the writer relies upon his own personal observations of foreign stocks in this country. In many cases the American-born child of foreign parents desires passionately to be a 'pure American,' to slough off and forget the attributes which characterize, as he or she thinks the 'wop' using this in a generic term of disparagement for the foreigner."

"In the second place it must be remembered that in 816,546 effective marriages of native-born there are many racially unlike matings. In three states, Massachusetts, New York and Connecticut, there were actually in 1919 as many or more matings in which both parents were foreign-born as there were where both parents were native-born, and in New Hampshire, Pennsylvania and Maine, the effective foreign ×foreign matings were more than half as numerous as the effective native× native matings. There can be no doubt that in these six states the less Americanized elements are multiplying too fast in proportion to the more Americanized elements."

Many students will take issue with the author's statement that the American-born persons of foreign parents have an antipathy toward marrying recent immigrants of the same race. This hardly can be considered as a prevailing sentiment in those sections where large foreign colonies predominate. Dr. Pearl's observation seemingly would apply only to those regions where the relative number of foreign whites was small. The degree of error arising from this source may be negligible but the lack of available data precludes its determination. While it is true that in the United States × United States group there are many racial crosses, it is equally true that in this same group there are many more crosses between members of the same foreign race which, from the narrow genetic standpoint of race amalgamation, are just as pure racially as if their parents had been born abroad.

But this source of error is discounted by the author who reasons that the only definition of an American is that of nativity. "An American is a person born in the United States [with apologies to the Canadians]. The only racially pure American is the Amerind. I can not see logically but that a person born in the United States in 1920 has just as much right to call himself an

American as one born here in 1620. And further this right is just as logically passed on hereditarily now as it was then." "Practically and in fact that is the way in which Americans of all varieties including that odd and rather dangerous creature now so much to the fore, the '100 per cent American,' have come into being!"

Leaving this debatable ground a study of Table V which has been reproduced here will show that there is a truly astounding amount of racial hybridization. Giving all sources of error their due weight and being reasonably severe with the United States ×United States group it seems safe to conclude that approximately 10 per cent of the children born in 1919 were first generation hybrids!

TABLE V. *Net effectiveness in producing next generation.*

Order	Race combination	Number of Births	Per Cent	Order	Race combination	Number of Births	Per Cent
1	U. S. × U. S.	816,546	65.123	42	Austria × Italy	323	.026
2	Italy × Italy	76,251	6.081	43	Canada × other foreign	315	.025
3	Russia × Russia	53,128	4.237	44	Germany × Poland	313	.025
4	Austria × Austria	46,407	3.701	45	U. K. × Germany	309	.025
5	Other foreign × other foreign	30,079	2.399	46	Scandinavia × U. K.	283	.023
6	U. S. × Canada	24,181	1.929	47	Scandinavia × Germany	278	.022
7	Poland × Poland	22,562	1.799	48	Hungary × other foreign	242	.019
8	U. S. × Germany	16,520	1.318	49	Ireland × other foreign	238	.019
9	Hungary × Hungary	14,624	1.166	50	Canada × Scandinavia	221	.018
10	U. S. × U. K.	14,339	1.144	51	Canada × Germany	220	.018
11	U. S. × Italy	12,559	1.002	52	Ireland × Germany	187	.015
12	U. S. × other foreign	12,234	.976	53	Scandinavia × Ireland	162	.013
13	Ireland × Ireland	12,035	.960	54	Poland × other foreign	161	.013
14	U. S. × Scandinavia	11,454	.914	55	Austria × U. K.	154	.012
15	U. S. × Russia	10,519	.839	56	U. K. × Italy	143	.011
16	Canada × Canada	9,616	.767	57	Ireland × Italy	139	.011
17	U. S. × Austria	9,600	.766	58	Canda × Italy	131	.010
18	Scandinavia × Scandinavia	9,519	.759	59	Italy × Russia	120	.0096
19	U. S. × Ireland	9,006	.718	60	Germany × Italy	110	.0088
20	Germany × Germany	6,595	.526	61	Canada × Russia	86	.0069
21	Austria × Russia	5,791	.462	62	Hungary × Italy	84	.0067
22	U. K. × U. K.	5,444	.434	63	Austria × Canada	79	.0063
23	U. S. × Poland	4,521	.361	64	Austria × Ireland	76	.0061
24	U. S. × Hungary	1,829	.146	65	Hungary × Poland	70	.0056
25	Russia × other foreign	1,447	.115	66	Austria × Scandinavia	68	.0054
26	U. K. × Ireland	1,161	.093	67	Italy × Poland	68	.0054
27	Austria × Germany	1,153	.092	68	Scandinavia × Russia	57	.0045
28	Canada × U. K.	1,001	.080	69	Scandinavia × Italy	40	.0032
29	Austria × other foreign	946	.075	70	Hungary × U. K.	36	.0029
30	Austria × Hungary	944	.075	71	Ireland × Russia	36	.0029
31	Austria × Poland	889	.071	72	Canada × Poland	33	.0026
32	Poland × Russia	884	.071	73	Ireland × Poland	30	.0024
33	Germany × Russia	815	.065	74	U. K. × Poland	28	.0022
34	Italy × other foreign	704	.056	75	Scandinavia × Poland	14	.0011
35	Germany × other foreign	638	.051	76	Hungary × Canada	12	.00096
36	Scandinavia × other foreign	597	.048	77	Hungary × Scandinavia	10	.0008
37	U. K. × Russia	560	.045	78	Hungary × Ireland	9	.0007
38	Canada × Ireland	552	.044		Total	1,253,848	100.004
39	U. K. × other foreign	463	.037				
40	Hungary × Russia	453	.036				
41	Hungary × Germany	397	.032				

Copied without recalculation from pp. 621–622.

"From Table V it is seen that 65 per cent of the children produced in the Birth Registration Area in 1919 were from American born parents while 10 per cent had one parent native born leaving approximately 25 per cent of the total births having both parents foreign born."

"From one point of view it will be regarded as alarming that but 65 per cent of the children born in this country have both parents native born. But, on the other hand, as the figures show, the proportion having both parents native born is overwhelmingly larger than that for any other mating."

It is apparent also that of all the foreign races just three groups amalgamate with native stock more frequently than with self. These groups are Canada; England-Scotland-Wales; and Germany. Contrary to expectation the foreign-born Irish marry amongst themselves approximately three times as often as they marry any other race including natives.

The following table shows the extent to which foreign-born immigrants marry within their race as compared with the marriages they make with native stock. Marriages in this case meaning biologically effective matings.

	% Pure Bred	*% Crossed with native*
Austria	81.0	12.0
Hungary	88.0	7.7
Canada	40.0	54.7
Denmark-Norway-Sweden	51.7	43.0
England-Scotland-Wales	33.3	52.5
Ireland	72.5	22.8
Germany	33.2	55.0
Italy	85.0	13.0
Poland	82.0	13.0
Russia	78.0	12.0

From this table it is seen that the race which fuses most readily with the native stock is the German while curiously enough only 22.8 per cent of the Irish amalgamate with native-born stock.

Not content with having exposed the fallacy of the general belief that immigrants do not amalgamate with the native stock Dr. Pearl disposes also of that other general opinion that the new arrivals would be better off on the farm.

"The native population has a *lower* vital index [100 births÷deaths] in the cities than in rural districts; the foreign population shows the reverse relation, the higher index being for city populations." "By and large, and with all factors included, as they are in the vital index, it appears that the foreign population, as it is actually constituted in the Birth Registration Area in respect of age, etc., is a biologically fitter population in the cities than is the native; while the native population is better under rural conditions."

From the standpoint of the negro problem the following conclusions are of interest: "Indeed one may say generally that, except in the rural districts of the southern states, practically never does the vital index of the negro populations rise to a value of as much as 100. But plainly enough any population with a vital index under 100 is a dying population. Such a population is bound, in the fullness of time, to disappear completely, if nothing whatever is done about the case. Nowhere in cities, even in the southern cities, does the value of the negro vital index get to 100 in a fairly normal year such as 1917."

"Even in rural portions of the Birth Registration Area the negro index does not approach in magnitude the total white index nor the native white index for the same communities. This is true in southern states as well as in northern. It would be difficult to find a more complete and critical demonstration than that furnished by these indices of the fact that the negro is biologically a less fit animal, *in the American environment physical, social and general than the white.* Under conditions *as they are*, Nature, by the slow but dreadfully sure processes of biological evolution, is apparently solving the negro problem in the United States, in a manner which, when finished, will be like all of Nature's solutions, final, complete and absolutely definite."

The solution of the population problem is believed to lie in a policy of periodic immigration. "From the standpoint of quality of the population in respect

of health, intelligence, and all round efficiency, it is suggested that the wisest policy from now on for the country to pursue would be one which might be called intermittent or periodic immigration. Let all immigration of any sort whatever be rigidly and completely prohibited for a period of say 20 years, to be followed by a period of say 10 years of free immigration, with only such restrictions physical, economic and criminal, as we have in the immediate past imposed During the period of no immigration the foreigners of the last influx and their children would become sensibly assimilated and fused into the American population. For the most part, they would have become Americans in a real sense of the word. Such a plan would further provide for that periodic inflow of new blood, of low living standards, which seems to be, both an economic and social necessity at least to civilizations which are still in the stage of industrial development and exploitation. Finally such a plan would, so far as one can foresee, postpone the period of pressing over-population as long as it can humanly be postponed, without the necessity of resorting to internal interferences of dubious practicability."

Although this analysis shows clearly that the foreign immigrant is fusing rapidly with the native stock—a condition deplored by most geneticists as one certain to dilute and degrade the races to which much of our present civilization is attributed Dr. Pearl again assumes the contrary position. Summing up the results of the vast experiment in human genetics which has gone on for three centuries in the United States he says: "When I compare the net result, as indicated by the human product now here—the product counted in the 1920 census—with the more nearly pure-bred peoples of Europe, I cannot force myself to that pessimistic outlook that I am told by some of my '100 per cent, Nordic' friends that I ought to. It seems to me, looking at the matter as a biologist, that a real, distinct, unique *American* people has evolved in the course of the experiment and is still continuing to evolve. Further, as people go, it is not a bad people. Its most interesting and valuable feature is that it is still changing and evolving. I can find no manner of bitter feeling or even regret that the pure English-Scotch-Welsh stock of the original settlers will eventually not be the dominant element in the complex of American germ-plasms that it has been in the past, though personally I am wholly of that stock, and am, for three centuries, an American. Such a state of affairs was, in the natural course of events, bound to come about. There cannot, by any possibility whatever, be anything approaching biologically pure race stocks in this country a century hence. There are practically none now, with the exception of the Jews, and there is every present reason to believe that even they will be far less pure in 2021 than they are in 1921."

"The kind of people who will survive and run the affairs of the country, say a couple of centuries hence, when population pressure will be intense, will, I think not be Englishmen, or Slavs, or Jews, or Italians, but *Americans*, of that type which has shown the greatest adaptability to the problems which life in this part of North America has presented. I think they will be just as gentle, as high-minded, as clever, as honorable, and as independent as any people on the face of the earth."

Most statistical treatises are shunned by the layman as being too dry and academic for any but statisticians but in shunning the present paper the reader will have missed an intensely interesting and intelligible analysis, for Pearl has conjured up a picture of racial conditions as they now exist in America that, even though the conclusion be accepted with reservations, furnishes a graphic base from which to peer into the future and in the hackneyed phrase of the book reviewers, "is nothing if not thought provoking."—*J. H. Kempton, Washington, D. C.*

MICROCEPHALIC PEOPLE SOMETIMES CALLED "PIN HEADS"

One of the most striking forms of congenital abnormalities is Microcephalus, characterized by small brain, weak nervous system, and low grade muscular co-ordination

CHAS. BERNSTEIN
Rome State School, Rome, New York

MICROCEPHALY in the human species is variously described as a condition in which the cranium and the cranial content capacity is so small as compared with the normal or average that there is not space for lodgment therein of a sufficiently large brain to direct, guide, and control human function in a normal way.

It is generally accepted that a human adult cranium measuring below 17 inches in circumference is markedly miscrocephalic, and anything below 19 inches is too small to contain therein a full sized or normal and complete functioning organ.

However, it is not alone the cranium or skull which is disproportioned, for casual observation shows that there are other physical abnormalities present in these cases, such as small stature, drooping shoulders, apparently long extremities, as legs and arms, loose joints, partially flexed knees when standing, and weak nervous system as well as weak minds, as revealed through lack of vim, early fatigue, low grade of muscular co-ordination, silly actions and expression; however, they are usually good, simple mimics, shy and cunning, able only to articulate a few indistinct monosyllable words. These individuals are often described or spoken of in a popular way as pin-headed, anthropoid, simian, theroid, pithecoid, atavistic, foxy, apish, mimics etc.

When we come to apply these various descriptive terms to individual cases we are at once struck with their apparent aptitude thereto; however, further analysis often proves some of these terms less scientifically accurate as, for instance, anthropoid or simian as indicating that when the individual stands erect the tip of the middle finger of the hand falls,—when the arm and fingers are extended and allowed to fall to the side of the standing individual,—too far down the thigh toward the knee as compared with a normal human being, whereas when the microcephalic is grasped by the two shoulders from behind and the collar bones and shoulder blades drawn back and the spine made wholly erect, the tips of the fingers assume nearly if not an entirely normal position with reference to the knee, thus showing that it is more a laxity of tissue and absence of nervous and mental vim and control than an abnormal bone or skeletal structure that is at fault in accounting for this symptom.

Atavistic, as applied to these individuals, assumes that herein is shown a tendency to retrovert to an ancestral type, supposing that in these families, or at least these individual cases, there is a devolutionary process going on for at least one generation, and that there is a hereditary tendency to strike back to a primitive type of man. It occurs about twice as often in males as females, and often more than one child in the same family, although so far as we can find, seldom in succeeding or intermitting generations of the same family as the following history corroborates.

Dr. Shuttleworth says "of congenital abnormalities the most striking is *microcephalus*. In its extreme form it is characteristic of a low form of idiocy, in which have been traced simian and even theroid resemblances. There are a series of gradations rising

through idiocy and imbecility to simple 'feeble-mindedness,' which is not infrequently associated with small-headedness. Microcephalus, however, does not depend solely upon diminutive size of head, as ascertained by measurement; and in our opinion the limitation of the term proposed by some to cases in which cranial circumference does not exceed seventeen inches, is scarcely scientific. There is a characteristic form, as well as size, of microcephalus heads; such, for example, as a narrow, rapid receding forehead, a somewhat pointed vertex, and a flat occiput. Though of course the frontal and parietal lobes are on a small scale, it is in the occipital and temporosphenoidal that we usually find the most striking evidence of arrest in development. A remarkable case ('Freddy'), for twenty years under the authors observation at Lancaster, was anatomically reviewed by Dr. Telford Smith and Professor Cunningham, of Dublin. His brain weighed only 12½ ounces; the convolutions were simple, though fairly distinguishable in the anterior lobes, but became rudimentary posteriorly, the occipital and temporosphenoidal lobes being indeed very imperfectly developed. This 'Aztec' like youth, who had large bright eyes, an aquiline nose, and somewhat receding chin, manifested good powers of observation, but was only able to express himself in a few monosyllabic words. He had considerable will power, and though it was found impossible to train him to much that was useful, he was in no sense a low-grade idiot. We have repeatedly seen boys and girls with heads measuring only nineteen inches, taught to read and write, and to do industrial work. Quality of brain is an important factor, as well as quantity, and in cases of microcephalus what little there is is usually fairly active."

There were five of these children—four boys and one girl—among a family of ten children variously interspersed as regards age.

These three boys' heads measured in in circumference 15″, 15½″ and 16″. They were all three able to dress and make their own toilet, and two of them learned to assist in dining room work, washing dishes and setting tables, and knew the difference between eight or ten plates on the table and the corresponding number of forks, spoons, and knives for a like number of places. They knew this not from counting—they were unable to count—but from relative position and habit of repetition.

Many cases have come to our attention where operation (craniectomy) had been done on the skulls of these individuals, hoping thereby to allow the cranium to expand and the brain to grow and develop, it being assumed that the sutures and fontanels had ossified and closed too early in life and thus confined and prevented the brain from normal growth. The results of these operations were never successful or promising and no experienced surgeon does the operation these days.

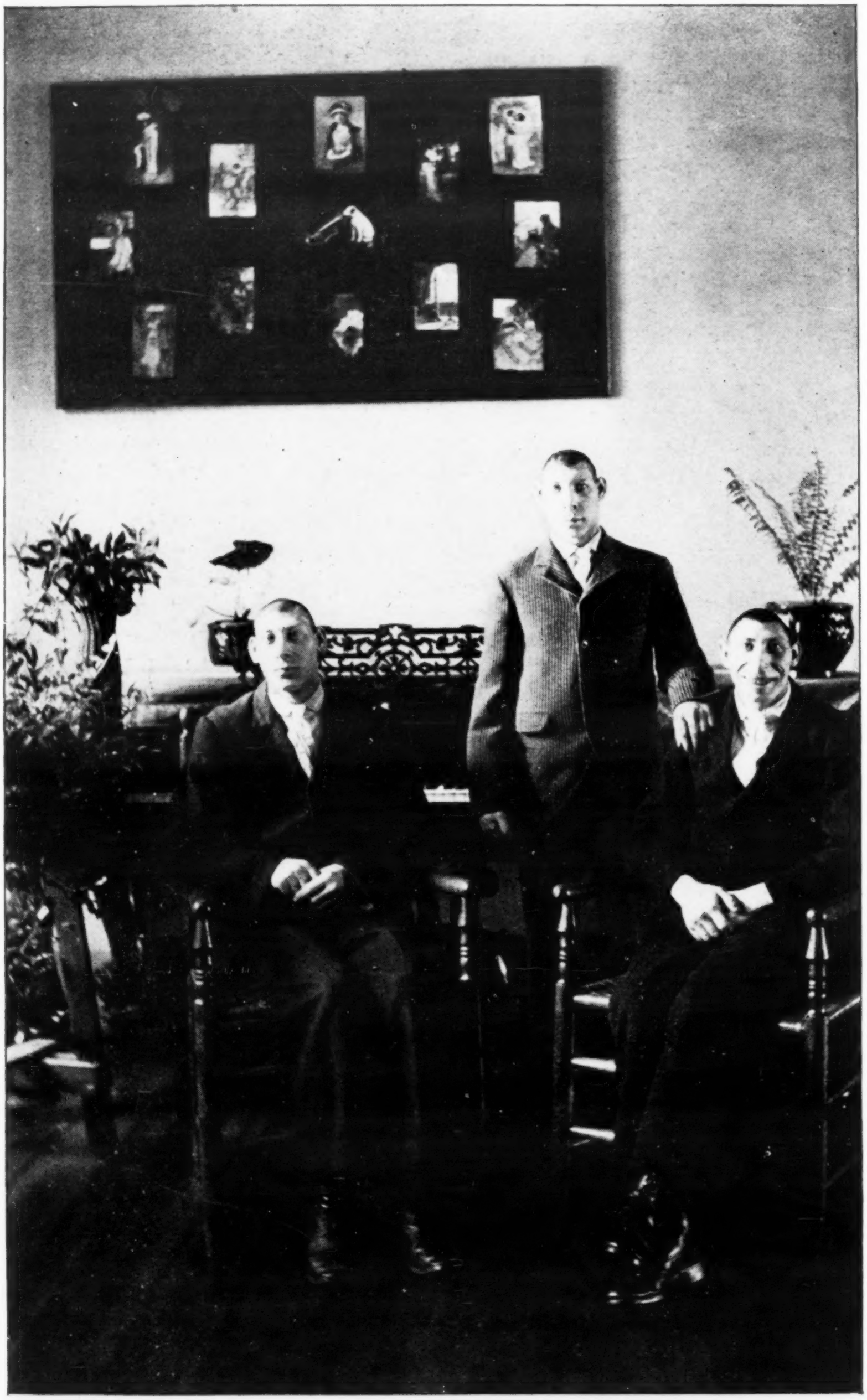
Many times as a result of pressure on the brain from scar tissue resulting from the operation, convulsion and paralysis ensue.

Due credit is to be given Miss Marjorie Fulstow for collecting this family record as follows:

FAMILY HISTORY OF THE PIN BOYS

The representatives of this family in the Rome School are August P. (IV, 13), Charles P. (IV, 14), and Raymond P. (IV, 17), all microcephalics of a pronounced type. The record states that August P. was born in New York State in 1888, and that he cannot read or write or learn anything; is clean in his personal habits, can speak a few monosyllables indistinctly and tries to tell his name. He was brought here from the School at Syracuse. When admitted to the R. S. C. in 1905, he tested three years mentally. He is employed in the patients' dining-room and is seldom disturbed; he was once known to strike an attendant.

Charles P. (IV, 14) was born in New York State in 1890, a microcephalic. In 1903 he tested four years mentally, while in 1914 he tested three years. He also was transferred from the Syracuse school to this institution.

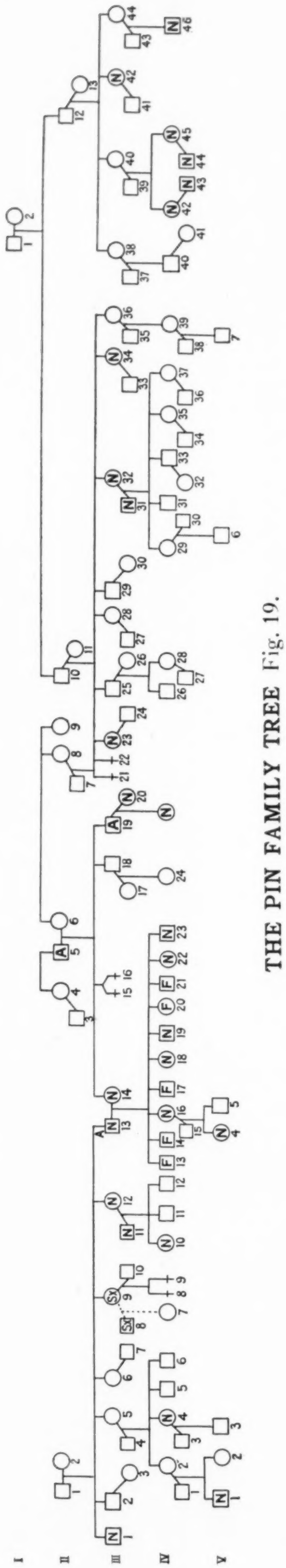


THREE HAPPY PIN BROTHERS

The form, as well as the size of the microcephalic head is characteristic, and abnormalities of other parts of the body frequently accompany the condition. There are cases on record of microcephalic brains weighing only eight ounces, while the weight of the average male brain is 48 ounces. Quality is more important than quantity, but it is not considered possible to attain normal mental development with a brain weighing less than 32 ounces. (Fig. 17.)

PROFILE VIEW OF THE SAME THREE PIN BROTHERS

Some Microcephalics learn to read and write, but these three boys never could be taught to count. Two of them had a mental age of three, the other of four years. On the theory that the condition is caused by too early ossification of the sutures and fontanels, operations have been attempted to enlarge the cranial cavity, but they never resulted in any increased development of the brain. (Fig. 18.)



THE PIN FAMILY TREE Fig. 19.

Raymond P. (IV, 17) was born in New York State in 1894. His understanding of language is very slight hearing apparently normal. He was admitted from the Syracuse school in 1910. In 1913 he tested three years mentally; he is now 21 years old and tests four years. He is very stupid and requires a great deal of attention; was employed a short time in the patients' dining-room, but later was of no use there because of his untidy personal habits.

PATIENT'S FRATERNITY

Mary P. (IV, 16) was born in New York State in 1892. She is quite a nice looking woman of medium height, fairly reserved, and courteous and shows evidence of a good bringing up; appears to be practical and to have very good sense, and is an intelligent woman. She is married to Mr. R. (IV, 15) who is a foreman in a factory. They live in the upper story of a house and the rooms, though small and few in number, are clean and well kept. They have two children, aged two years. and six weeks, respectively, both whom are attractive children; the older one, Irene acts decidedly like a normal child. The younger one who was asleep when I called does not appear to be abnormal in any way.

Grace P. (IV, 18) was born in New York State in 1895, is a pretty, well formed, intelligent and capable girl. She is the only member of the family who is working at the present time. She has earned her living as a housemaid, but is now (1921) a stenographer.

Warren P. (IV, 19) was born in New York Sate, 1897, is six feet tall, well formed and athletic. He has a grade achool education and is now a good carpenter, according to his father.

Wilhelmina P. (IV, 20) was born in New York State in 1899, and, like her brothers, is a pronounced microcephalic She is clean in her personal appearance, but it is not known whether this is due to her own efforts or to those of her mother. She is cross-eyed and one eye is very bad looking; it is not known whether she can see out of it or not. She has a very bad temper and is

becoming more troublesome and harder to control as she grows older. She was sent to the Newark State School in 1921.

Walter P. (IV, 21), born in New York State in 1901, was admitted to the Rome school in 1921 and later died. He was also a pronounced microcephalic like his three brothers at this institution. He was of a much better disposition then his sister (IV, 20) and much easier to manage for that reason. He was very tractable until crossed or thwarted in any desire; had a little understanding of language and could talk a little.

Gertrude P. (IV, 22), born in New York State in 1904, has a grade school education, is studious, bright and pretty.

Earl P. (IV, 23), born in 1907, is an unusually bright and attractive boy, but skips grades at school.

PATIENTS' FATHER

August P. (III, 13) was born in New York State in 1862; has lived most of his life in New York State. He has unusually good health, has had no operations and the only diseases he has had are the ordinary infectious diseases of childhood. He is a large, fine looking man, erect and intelligent, appears to have fairly good sense but has been very intemperate, though his brother, William P., says that he is doing much better now. He is not related to his wife. His occupation at all times has been that of a carpenter. Although Dr. L. did not notice anything peculiar about his head I have heard from two sources that it slopes back quite abruptly from his eyebrows. They say that he is a fine looking man until he takes off his hat. Some of their friends think that this is a curse put upon the family because Mr. P. was engaged to marry another young woman and then fell in love with and married Mary S.

FATHER'S FRATERNITY

Fred P. (III, 2), born in Germany, is described by his relatives as being all right physically and mentally. He is married and lives in Canada. A letter from his daughter shows her to be intelligent and fairly well educated.

William P. (III, 1), born in Germany, is a very pleasant and courteous man, has a common school education, kept a saloon in the foreign section of a city, but has no appearance of intemperance, and is an intelligent man. Like the rest of the Pin family he has heard that far back in the history of the mother's family there have been reports of peculiar children. This rumor, however, seems to be unfounded; nothing definite is known about it, and it seems to be something invented by the Pins to account for the children of August P.

Christina P. (III, 5), born in New York State, has no education to speak of, and talks with a decided German accent. She lives with her husband, Mr. S., in a well built and comfortable house in section of the city where the more prosperous of the working class live. She is about as intelligent as the average uneducated German women. Like the rest of the Pins she thinks that if there is a heredity cause for the children of August P. it is on the mother's side.

CHILDREN OF III, 5 & 4

Ada S. (IV, 4) is a neat, clean, industrious and bright young woman. She went through the ninth grade at school and intended to finish school but failed in one subject and became discouraged and quit. She married Mr. G. (IV, 3) and they have an eight month old baby, seemingly normal. They live in a house of average size which looks well kept.

Bertha S. (IV, 2) has a grade school education, is married and lives near her mother. She has two very attractive children, a boy of five and a girl younger.

John S. (IV, 5), finished the ninth grade at school. He is now working for an insurance company and is self supporting. He is unmarried and in appearance is tall and slim.

Fred S. (IV, 6) is still in school, now about the first year of high school.

Katie P. (III, 6) married Mr. K. She is described by her sisters and the relative of Mrs. P. as being all right mentally and physically.

Mary P. (III, 9) is described as being very peculiar looking. She is very dark with eyes close together and very black hair which grew far down on her forehead. She had a peculiar way of looking at people out from under her bushy eyebrows. She had an illegitimate daughter, then married a Mr. N. (III, 10) and had two children who died in youth, one of diphtheria and the other of convulsions while teething. III, 5 says that there was nothing wrong with any of these children.

Anna P. (III, 12), who is the youngest of the family, was born in New York State. She is a very well built, healthy appearing woman. She has a better education than her sister (III, 5), is intelligent, makes a good appearance and is decidedly normal. She married Mr. E. (III, 11), who has a plumbing establishment in the down-town section of the city. They live in a very good section of the city in a nice, newly built house which has an air of refinement about it.

CHILDREN OF III, 12 & 11

Edna E. (IV, 10), born in New York State in 1897, is now attending the high school in her home city.

William E. (IV, 11), born in New York State in 1901, is also at school where he is reported to be getting along nicely.

Robert E. (IV, 12), born in 1905, is also in achool; reported to be bright.

FATHER'S FATHER

Fred P. (II, 1), born in Germany, had a common school education; principal residences Germany and New York State; married when quite young. While in Germany his occupation was that of a soldier; he was wounded in the war of 1870. In America he was a saloonkeeper. He had no grave illness that his son knew of; died at 75 years of age. He was not related to his wife. As the Pins are people who do not know much about their family it is impossible to find out anything about them farther back than this generation.

FATHER'S MOTHER

Wilhelmina V. (II, 2), born in Germany, died in New York State at 72 years of age (kidney trouble). She was noted for her great strength and ambition. The family tell an anecdote of how this woman during the war of 1870 picked up two soldiers one after the other who were making themselves a nuisance around the place and threw them over a manure pile.

PATIENT'S MOTHER

Mary S. (III, 14), born in New York State in 1866, had a common school education; principal residences in New York State; married August P. (III, 13) in 1887; was a house-maid until her marriage. She had the ordinary children's diseases but otherwise was not sick a day in her life except when her children were born. she is a good house-wife, keeps all the children tidy and is kind to the defectives. She has an unusual amount of intelligence for an uneducated German woman, and is very clean in appearance. Dr. L. was very much impressed with her as a woman of unusual patience and wonderful in managing the children and keeping the household together. She is decidedly a woman of normal mental ability, and is faithful to her husband and family. After the three were put in institutions, her brother, Frank S., offered to take her and her children and give them a good home if she would leave her husband, but this she refused to do and is still living in very poor circumstances when she might be living in luxury. The family live in a very poor house where all the houses look run-down and poorly kept. No one could make Mrs. P. admit that there was anything wrong with the three oldest children for a long time. She would always say that they were as bright as any of the children, and it was not until August (IV, 13) attempted to put his mother in the oven of the kitchen stove that she would have the microcephalics put in institutions.

MOTHER'S FRATERNITY

Charles S. (III, 18), born in New York State in 1860, moved to the West sometime ago and has lived there ever since. I have communicated with him

and he says that he does not know of any other cases of feeblemindedness in the family. He is self supporting and according to his sister (the patients' mother) has a normal daughter ten years of age.

Frank S. (III, 19), was born in New York State in 1864; has not much education; married Louise W. a woman of good business ability. He kept a saloon and has made a great deal of money, not due to his long sightedness, however, except in the matter of economy, but to the business ability of his wife. He has been described as still possessing in some form or other "the first nickel he ever earned." He was described as being a mutton-head and after meeting him I was convinced that he merited the description. The S. family live with their one bright appearing daughter in one of the finest residence sections of the city, where they have built a house which is almost palatial. Their money evidently hires their taste, for everything in the house is in keeping with the exterior. Although they posses this fine house, they spent much of their time in their business place. Dr. L. visited the house on four different days and found no one at home; the fifth time, however, was on a Sunday morning and we succeeded in gaining admission after ringing the bell a long time.

One can tell from the appearance of Mr. S. that he is very intemperate. He is the opposite of his siter in the matter of patience, and is out of patience with her at the present time upon that very subject.

There were a pair of twins (III, 15 & 16), who died in infancy. From three sources we have it that the twins were all right physically and mentally, and that they died of cholera infantum when they were about two and four weeks of age respectively.

MOTHER'S FATHER

Jacob S. (II, 5), was born in Germany; supposed to have had a common school education; lived the greater part of his life in New York State where he was the proprietor of a saloon for many years; was a thrifty business man; had no grave illness nor operations; was very intemperate especially after the death of his wife. He died at the age of 56 years.

MOTHER'S FATHER'S FRATERNITY

Elizabeth S. (II, 4), married Mr. T. and lived for many years in Ohio. Relatives of Mrs. P.'s mother say that the family are bright people as far back as they know.

MOTHER'S MOTHER

Adeline K. (II, 6) was born in Pennsylvania and died at the age of 44 years in child-birth when the twins were born. No cases of feeblemindedness in the family.

MOTHER'S MOTHER'S FRATERNITY

Harriet K. (II, 8), married Mr. W. and had two children who, according to some stories, were eyeless, and, according to others, had eyes but could not see, while others state that the eyes of these children were not in the right place. The mother herself (II, 8) is described as an intelligent woman with no peculiarities of mind or body.

Mary Anne K. (II, 9), unmarried, is a keen old lady. She was present at the birth of the oldest Pin boy and said to the doctor as soon as she saw him "that child is not right," but the doctor ridiculed the idea as pure imagination.

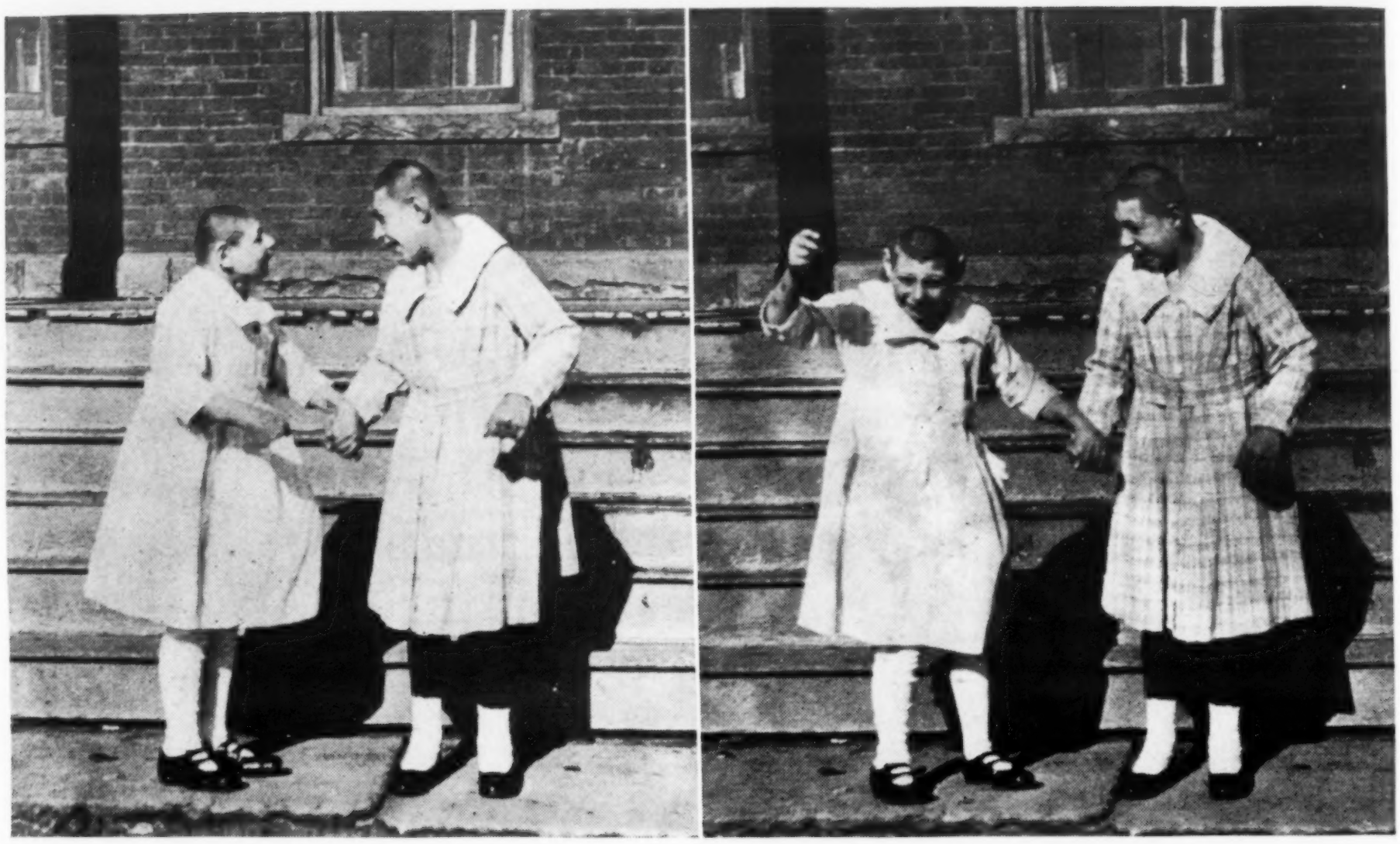
Jacob K. (II, 10), as far as I can find out, was of good mental ability. He had no microcephalic tendencies; his daughter says that although he is a large man his head was unusually large and he usually had to have his hats made to order. He was married and his children are as follows:

Rose K. (III, 23), married Mr. T.; has no children. She is a pleasant and intelligent woman of about 70 years of age and lives with her sister (III, 32).

John K. (III, 25) is a good business man. He is married and has a son who is a lawyer, and a daughter who is married and lives in New Jersey.

Lavina K. (III, 28), married Geo. B.; had no children; died of heart trouble.

George K. (III, 29) was a painter



TWO MICROCEPHALIC GIRLS—NOT RELATED TO EACH OTHER OR TO THE PIN FAMILY

Microcephaly occurs about twice as often in men as in women. There is generally more than one case in a family, although all the children are not microcephalic. Apparently there was no hereditary cause for the cases recorded in this article. (Fig. 20.)

who lived in Ohio; died at the age of about 60 years as the result of lead poisoning.

Sarah K. (III, 32) married Peter H. (III, 31) and lives in a small cottage. The house and grounds are neatly kept and although it is a modest dwelling, there is no evidence of shiftlessness there. Mrs. H. is an intelligent and refined woman who is interesting to talk to; she seems to be honest and thoroughly respectable, and has a fairly good education.

CHILDREN OF III, 31 & 32

Lillian H. (IV, 29) married Mr. S. and lives in Canada with their one son. I was shown a photograph of the three and they all appear to be of at least average mental ability.

Charles H. (IV, 31), a painter, unmarried, lives at the home of his parents. He was away at work when I called. His mother says he is of good mental ability.

George H. (IV, 33) is married but has no children. He was a saloon keeper in New York State; he and his wife lived over the saloon which was in the residence district of the city.

Sarah H. (IV, 35) lives in Ohio with her husband who is at the head of a bond department of a large bank, according to Mrs. H. (III, 32).

Olive H. (IV, 37) married a man who is an upholsterer. They live at the home of III, 37 who is a widow.

Adaline K. (III, 37) married Mr. E., who died several years ago leaving little property. Mrs. E. keeps a small grocery store, at the rear of which she lives with her niece and nephew; she is a lady in every sense of the word and uses the best of language in conversation. Her rooms, though small, show evidence of good taste. She says that they have often discussed the Pin children and wondered what the cause was, but did not know of anything in the family that might possibly account for their peculiarity. She impressed both Dr. L. and myself with her apparent reliability and honesty.

Alice K. (III, 36) married a brother

of III, 31, and lives in New York State where they own and manage a peach farm. She has one daughter who is now married and has a bright son.

John K. (II, 12) came to New York State with his parents from Pennsylvania on horseback. He has been dead several years; is reported to have been bright; was married and had children some of whom married into very good families:

Mary K. (III, 38) married a physician and lived in the west; they had a son who is now a physician and who married a normal woman who was a nurse in a hospital.

Martha K. (III, 40) married Mr. S.; had two daughters, one of whom married a leading florist, and the other married a former attorney general of New York.

Another daughter (III, 42) of John K. married a lawyer.

Another daughter (III, 44) married Mr. L. and they have a son who is a physician.

MOTHER'S MOTHER'S FATHER

K. — (I, 1) a Pennsylvania dutchman from Reading, came to New York State on horseback, accompanied by his entire family. He was a blacksmith; died at the age of over 70 of bloody dysentery.

MOTHER'S MOTHER'S MOTHER

Sarah R. (I, 2) came originally from England; married I, 1 in Pennsylvania; died of cancer at the age of seventy-eight.

SUMMARY

In this family we found five of the ten children microcephalics of a pronounced type when the father and mother were both of good physical type and mental ability, and the only family factor reflecting degeneracy, so far as we can find out, is alcholism.

Present Status of the Journal of Heredity

The Council is much gratified to be able to announce a grant from the National Geographic Society to the American Genetic Association which will make it possible to issue the deferred numbers as rapidly as the printer can handle the material.

The grant received from the National Geographic Society was in accordance with the following resolution adopted by the Research Committee of that Society on January 20, 1922:

"The National Geographic Society hereby makes a grant of three thousand dollars to the American Genetic Association for the encouragement of research in genetics in relation to geography, the fund to be used for the publication of illustrations that constitute a record of the research work of plant and animal breeders."

This timely act of the National Geographic Society in support of research in genetics will insure the regular publication of the JOURNAL. It is earnestly hoped that by the end of the year the membership can be increased sufficiently to make the JOURNAL self-sustaining. All members of the Association are urged to use their best endeavors in adding to the membership. It is believed that with 5000 members *in good standing* the JOURNAL could be published without other financial assistance. This membership increase should be made without delay in order that there shall be no set-back in publication again this year.

The membership of the American Genetic Association has increased steadily in recent years, but the revenue from membership dues has never been sufficient to pay the entire cost of publication of the JOURNAL, the deficit having been made up each year by a few members who have contributed generously for this purpose. It was hoped that when the membership should reach its present figure of 3625 the JOURNAL would become self-sustaining, but the continued high cost of printing resulted in such a serious deficit in the latter part of 1921 that it was impossible to continue the issue of monthly numbers as they became due.

ORIGIN OF FALSE WILD OATS[1]

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THE occurrence of false wild oats in cultivated varieties of *Avena sativa* and *A. orientalis* has been observed by several plant breeders. The question of their origin is one which has given rise to rather spirited discussions. Nilsson-Ehle (1911) contends that false wild oats are due to a loss mutation whereas Tschermak (1914) and Zade (1918) contend that they are the result of natural crossing. Zade's views are summarized in his monograph, Der Hafer, pages 217 to 225 inclusive.

During the summer of 1920 false wild oats were observed in a number of different pure lines of oats growing on University Farm, at St. Paul, Minnesota. The lines in which false wild oats appeared were carefully examined, and a collection of individual plants with different phenotypes was made. In this paper only the false wild oats which appeared in the varieties Victory, Garton 784, and Aurora are discussed. The material which was collected at University Farm[2] was grown during the summer of 1921 in the plant breeding nursery at Morgantown, West Virginia.

As Nilsson-Ehle has pointed out, false wild oats differ from the cultivated varieties in which they appear in awn development, articulation of both the upper and lower seeds, and in the amount of pubescence around the articulation. Homozygous false wild oats bear heavy geniculate awns and have distinct fatua-like articulations surrounded by dense tufts of hair on both the upper and lower seeds. In general, heterozygous false wild oats bear heavy geniculate awns on the lower seeds only. On the lower seeds the articulations and the amount of hair around them are intermediate between these same characters in the homozygous false wild and cultivated forms. The upper seeds of heterozygous false wild oats are very similar to the upper seeds of cultivated oats.

VICTORY[3]

In 1918 a number of panicle selections were made from Victory oats at University Farm. In 1920 one of the plant rows which represented the progeny of a single panicle was found to contain false wild oats. The homozygous and heterozygous false wild Victory plants were easily distinguished from one another as well as from the true Victory plants. All forms had white seed and open panicles but the three different groups were clearly separated in respect to awn development, articulation of the seeds, and pubescence around the articulation. Seed of individual plants of each of the three categories was grown separately in 1921. From Table 1 the character of the parent plant and the nature of its progeny may be determined. All the plants produced white seed. Homozygous false wild Victory and Victory plants bred true whereas the heterozygous false wild Victory plants produced progeny which again segregated into sativa-like, heterozygous, and homozygous false wild forms. The 15 individual plant rows coming from seed of heterozygous plants produced a total of

[1] Contribution from the Department of Agronomy, West Virginia Agricultural Experiment Station, Morgantown. Published with the approval of the Director.

[2] The writer is indebted to Dr. H. K. Hayes for permission to transfer the seed which produced the plants reported below from the Minnesota to the West Virginia Agricultural Experiment Station.

[3] The writer is indebted to A. Berg, Assistant Plant Pathologist, for the photographs; and to T. E. Odland, Assistant Professor of Agronomy, and K. S. Quisenberry, Instructor in Agronomy, for their aid in collecting the data.

OAT PANICLE TYPES

The normal panicle of the variety Victory is on the left (awns on lower kernels only), and in the center is the heterozygous false wild (only lower kernels of spikelets awned), and on the right the homozygous false wild (usually heavy, geniculate awns on both kernels in a spikelet). Apparently the false wild oats are true mutations and not crosses with wild oats because the segregation of the progeny of the false wild forms is very different from that of actual crosses. (Fig. 21.)

TABLE I: *Data showing the nature of the progenies from individual plants of Victory oats, heterozygous false Victory, and homozygous false Victory; all the progeny of a single plant*

Parent Class	Row number	Number of plants: Victory	Het. f. Vic.	Homo. f. Vic.	Parent Class	Row number	Number of plants: Victory	Het. f. Vic.	Homo. f. Vic
Victory	1S	16			Het. false Vic.	14S	4	13	3
"	2S	20			" " "	15S	4	11	6
"	3S	19			" " "	16S	4	10	7
"	4S	18			" " "	17S	1	18	3
"	5S	19			" " "	18S	3	8	8
Homo. false Vic.	6S			20	" " "	19S	2	11	6
"	7S			17	" " "	20S	7	7	6
"	8S			19	" " "	21S	2	12	2
"	9S			16	" " "	22S	6	9	5
"	10S			16	" " "	23S	4	11	4
Het. false Vic.	11S	4	11	6	" " "	24S	3	10	6
" " "	12S	4	12	6	" " "	25S	3	9	5
" " "	13S	3	11	7	Total Het. f. Vic.		54	163	80
					Expectation (1:2:1) P=0.0256		74.25	148.50	74.25

NORMAL PANICLE AND FALSE WILD FORMS OF THE CARTON 784 VARIETY OF OATS

It is not hard to distinguish the three types, the homozygous false wild form on the left, the heterozygous false wild in the center, and the Garton 784 on the right. Heterozygous false wild oats are intermediate between the other forms. They do not breed true to type, whereas the other two forms do, and their progeny segregate into sativa-like, heterozygous false wild oats, and homozygous false wild oats. (Fig. 22.)

54 Victory, 163 heterozygous false Victory, and 80 homozygous false Victory plants. This ratio does not agree very closely with monohybrid expectation ($P=0.0256$). In only three out of one hundred trials would divergencies as great as this be expected solely due to chance.

GARTON 784

False wild oats were also observed growing in a pure-line selection of Garton 784 made at the Minnesota University Farm, in 1915. Here, as in Victory, it was easy to distinguish the three categories of plants on the basis of awn development, pubescence, and articulation. On the other hand, the homozygous and heterozygous false wild oats as well as the true Garton 784 had black seeds and side panicles but were non-liguled forms. The parent plants classed as homozygous false wild Garton 784 and homozygous Garton 784 bred true to these types respectively. The 16 parent plants classed as heterozygous false wild Garton 784 produced a total of 81 Garton 784, 122 heterozygous false wild Garton 784, and 55 homozygous false wild Garton 784 ($P=0.0498$). Here again theory does not agree very well with observation. The segregation, however, is similar to that obtained from the heterozygous false Victory plants. Considering both varieties together there were 135 cultivated, 285 heterozygous false, and 135 homozygous false forms. This is obviously a 1:2:1 ratio ($X^2=0.4053$; $P=$ close fit). Nilsson-Ehle (1911) and others obtained similar segregation.

AURORA

Aurora is a pure line selection made by Mr. C. W. Warburton of the United States Department of Agriculture. It has a short plump yellow seed and is

early in maturing. The sample grown at University Farm was obtained from the Kansas Agricultural Experiment Station. Two plants of homozygous false wild Aurora were found in the Aurora variety. A careful search in the rod rows did not reveal a single apparently heterozygous plant. The two homozygous false wild Aurora plants bred true. However, one of the 19 plants selected as pure Aurora gave progeny which segregated into 6 homozygous false wild Aurora and 13 which were apparently Aurora. It is possible that the phenotypes of homozygous Aurora and heterozygous false wild Aurora are very similar. More evidence is needed to clear up this point. As in Victory and Garton No. 784, the false wild Aurora seed has the same characteristics as the variety in which it appeared except in awn development, articulation, and pubescence. (See Figures 21 and 23.)

F_2 GENERATIONS OF CERTAIN OAT CROSSES

In connection with the consideration of the origin of false wild oats, certain F_2 generations of fatua-sativa and fatua-orientalis crosses are of interest. The crosses mentioned below and the plants reported above were grown in the same nursery and the same year at Morgantown.

The F_2 generation of a cross between a brown, hairy wild oat and Victory showed unmistakable evidence of segregation with respect to panicle type; size, shape, and color of seed; and amount of hair on the lemma as well as around the seed articulation. The segregation with respect to the character of the articulation was approximately one fatua to three non-fatua types as has been observed by others (Zade, 1912; Surface, 1916). Differences in panicle type were also obtained in the F_2 generation. The panicle of the brown, hairy wild parent is much longer, and has longer branches than the panicle of Victory. In the F_2 generation of another cross, Victory with a yellow wild oat, distinct segregation occurred with regard to the same characters mentioned above except pubescence on the lemma. The yellow wild parent used in this cross has hair only around the articulation and not on the other regions of the lemma. (See Figure 23.)

The same wild parents were crossed reciprocally with Garton 748, a variety similar to Garton 784 except in awn development and length of rachilla on the lower seed. False wild oats were found in the variety Garton 784. The F_2 generations of these crosses exhibited segregation similar to that noted in connection with the Victory-fatua crosses. In the Garton 748-fatua crosses, however, the difference in panicle type between the parents is more marked. Garton 748 is a side-panicled and non-liguled form. Figures 2 and 5 illustrate some of the F_2 segregates

TABLE II: *Data showing the segregation with respect to ligules in the F_2 generations of certain oat crosses*

Name	Culture number	Number of F_2 plants	
		With ligules	Without ligules
Garton 748 X Brown Hairy Wild Oats	12–1	68	1
	12–2	72	1
Reciprocal	13–1	57	1
	13–2	57	2
Garton 748 X Yellow Wild Oats	8–1	75	0
	8–2	61	2
Reciprocal	9–1	62	1
	9–2	58	2
Total		510	10

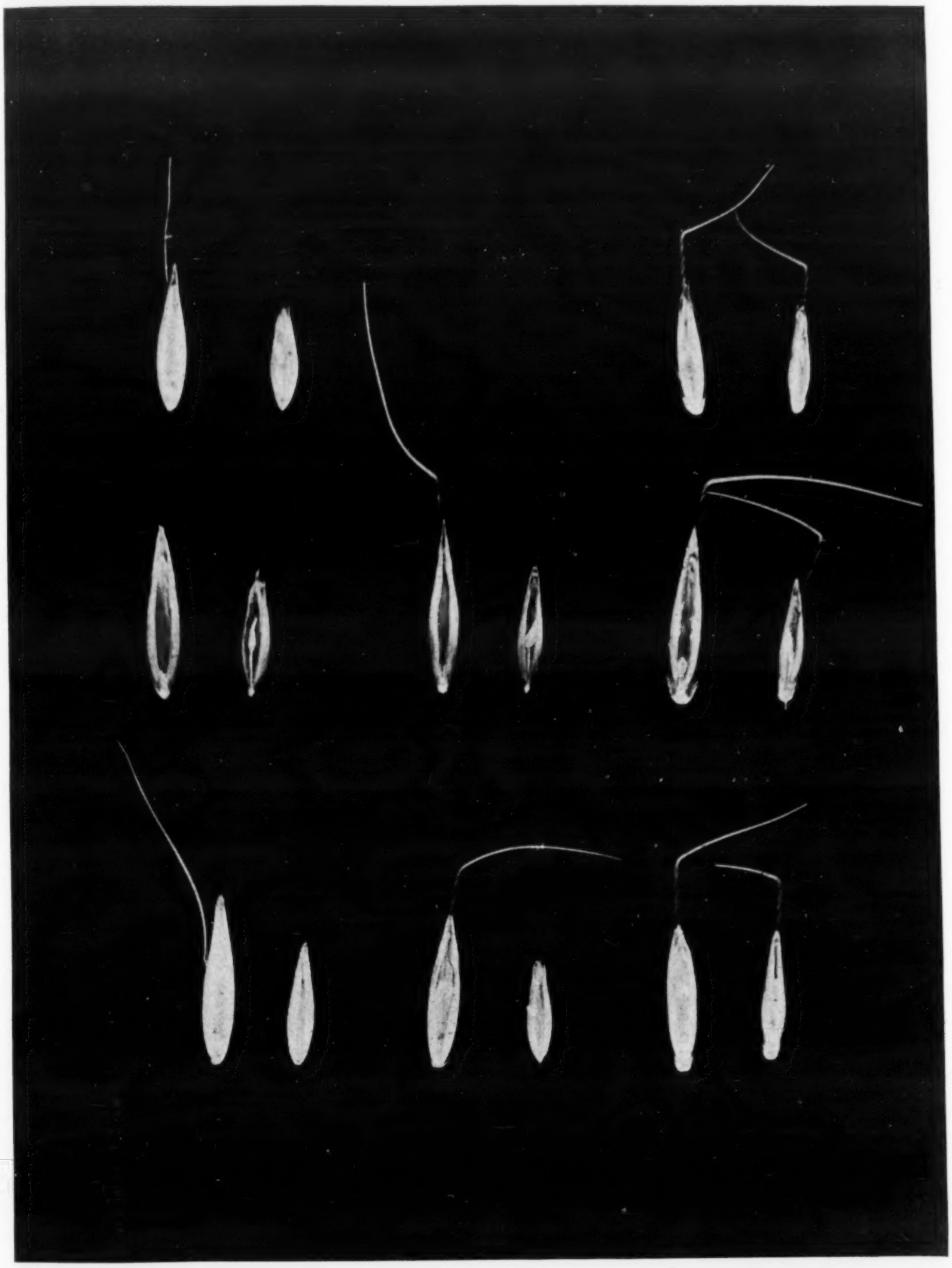
obtained. The segregation of the F_2 generations with respect to the presence or absence of a ligule is shown in Table II. In these crosses there are apparently three factor differences operating in the inheritance of the ligule character. In a total of 520 F_2 plants only 10 were without ligules. Assuming that three independently transmitted factors are involved, the presence of any one of which gives rise to a ligule, the deviation from the expected ratio is 1.0 times its probable error. In some other crosses (Nilsson-Ehle 1909; Love and Craig 1918) the presence or absence of a ligule apparently involves one, two, three, or even four factor differences.

THE F_2 AND F_3 GENERATIONS OF A VICTORY-GARTON 784 CROSS

The parents of the Victory-Garton 784 cross differ with respect to panicle type, seed color, and ligules. Segregation with respect to these characters appeared in the F_2 generation. Approximately three-fourths of the F_2 plants had black and one-fourth had white seeds. The segregation with respect to ligules was 489 with ligules to 38 without ligules. The 88 families of this cross which were grown in F_3 verified the F_2 segregation. Of these F_3 families, 36 bred true to the liguled condition; 20 segregated in the approximate ratio of 3 liguled to 1 non-liguled plant; 23 segregated in the approximate ratio of 15 liguled to 1 non-liguled plant; and 9 bred true to the non-liguled condition. The respective number of families expected in each category on a two-factor basis was 38.5, 22, 22, and 5.5 respectively. Theory and observation agree very well in this case, the value of P being 0.4609. Deviations as great as this, due solely to the errors of random sampling, would be expected in about one-half of the cases.

DISCUSSION

From the facts brought out above and an examination of the figures, it is obvious that the segregation observed in the F_2 generation of fatua-Victory crosses and fatua-Garton 748 crosses is very different from that among the progeny of heterozygous false wild oats. In the latter there is apparently but a single factor difference involved whereas in the fatua crosses there are undoubtedly several factor differences involved. Zade (1918) accounts for this difference by assuming that the natural cross between fatua and cultivated forms which gave rise to a particular false wild oat occurred many years previous ("Kreuzung jahrelang zurückliegt . . . ") to the time when the false wild form was actually observed. If one accepts Zade's hypothesis as an explanation of the origin of the false wild oats reported in this paper one must account for the selective elimination of all phenotypes except the three types, cultivated, intermediate, and true false wild oats. In each case the intermediate and true false wild oats were apparently identical with the variety in which they were found except with respect to awn development, articulation of the seeds, and pubescence around the articulations. These three characters collectively depend on a single factor difference for their particular development in each of the three categories, homozygous cultivated, heterozygous false, and homozygous false forms. How may one account for the elimination of all the liguled plants which result from a cross between fatua and non-liguled orientalis forms or the elimination of all open-panicled plants? The white color of the false wild Victory seed and the yellow color of the false wild Aurora seed are other instances of recessive characters whose exclusive presence must be explained either on the basis of selective elimination or the possibility that the progeny of the particular fatua-sativa natural crosses showed no segregation with respect to color of seed. Similarly in the case of Garton 784 in which false wild oats were found the exclusive occurrence of black seeds could only be explained on the basis of selective elimination, or that in this case false wild oats ap-



COMPARISON OF THE SEEDS OF THREE VARIETIES OF OATS

The upper seeds of the oat spikelet differ from the lower. On the left are the lower and upper seeds from the spikelets of three varieties of oats (Aurora, Garton 784 and Victory). In the center column are the heterozygous false wild forms of two of these varieties and on the right are the homozygous false wild seeds. The upper seeds of the intermediate form are similar to the normal upper seeds, but the lower seeds resemble the homozygous form. (Fig. 23.)

peared because of a natural cross between a dark fatua and Garton 784.

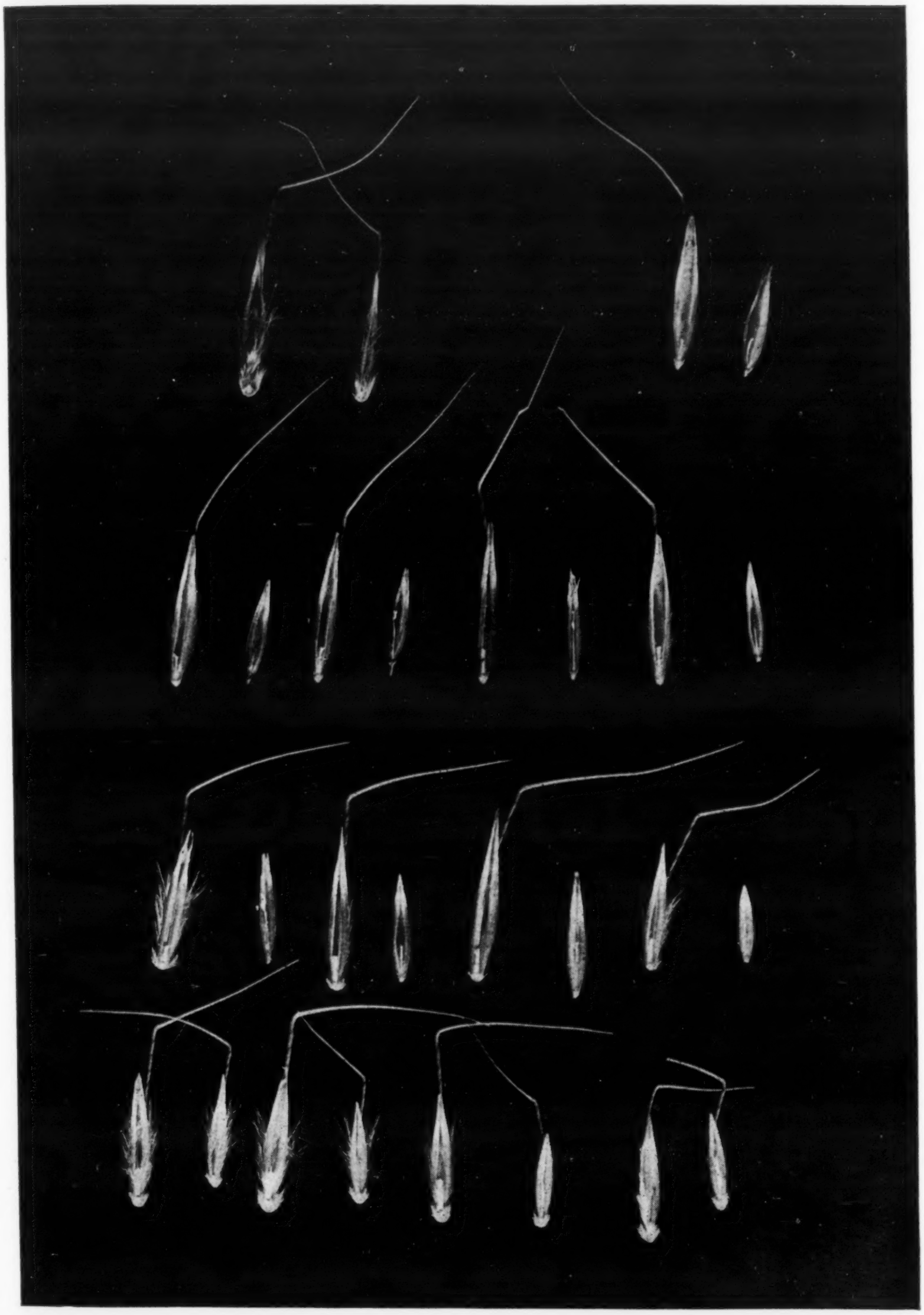
In comparing the size and shape of seed of the three different phenotypes growing in rows segregating for false wild oats with the seed phenotypes of the F_2 generations of artificial fatua-sativa and fatua-orientalis crosses, (Figures 23 and 24) considerable differences are apparent. False wild Aurora seed is very similar in size and shape to the seed of true Aurora; a similar relation holds between the false wild and cultivated forms of Garton 784 and Victory respectively. In the F_2 generations of actual crosses between fatua and cultivated varieties it is clear that segregation occurred. Here again if one accepts natural crossing as the explanation of the origin of false wild oats, one must postulate that an elimination of phenotypes with respect to size and shape of seed has taken place or that the progeny of a natural cross between fatua and cultivated forms did not show segregation with respect to these seed characters.

Either of the two explanations is quite unlikely, particularly in the case of false wild Aurora. It is more probable that Nilsson-Ehle's hypothesis is correct, namely that the origin of false wild oats is the result of a mutation. The exclusive occurrence of monohybrid segregation among the progeny of heterozygous false wild oats is in itself evidence of a mutation. The single factor difference between the false wild oat and the respective variety in which it was found can most easily be explained as a mutation i.e., a change in the chromosomal locus which is concerned with the phenotypic expression of awn development, seed articulation, and pubescence around the articulation. It is true that monohybrid segregation also occurs with respect to character of seed articulation and certain closely associated characters in fatua-sativa and fatua-orientalis crosses but in addition there is segregation for characters not closely associated with the type of articulation. This is important evidence in connection with considering the origin of false wild oats.

Nilsson-Ehle points out one objection to Zade's hypothesis in explaining the origin of the false wild oats observed by the former. Fatua oats are not found in the vicinity of Svalöf. Zade found a positive correlation between the number of fatua forms and the number of "intermediate" (heterozygous false wild oats) forms present in any particular variety. Tschermak and Zade also suggest that natural crosses between cultivated varieties may explain the origin of false wild oats. This explanation is open to objections similar to the ones pointed out against accepting the hypothesis that false wild oats are due to natural crosses between fatua and cultivated oats. A satisfactory explanation other than a mutation for the exclusive occurrence of monohybrid segregation in the progeny of heterogygous false wild individuals has not been made. In the twelve pure lines, two commercial varieties and one F_2 generation of a cross (Glockenhafer II $\times$ Grossmogul) in which Nilsson-Ehle found false wild oats and in the three varieties of very different morphological aspect reported in this paper, the false wild oats and the respective variety in which they appeared differ only in awn development, articulation of the seed, and pubescence around the articulation. These three characters are conditioned by a single factor difference. Moreover, if natural crossing between cultivated forms is the cause of false wild oats it is rather singular that apparently they have not been observed or at least not reported more frequently by plant breeders who have made extensive studies in oat hybridization.

The false wild oats in Victory were discovered in the second generation of the progeny of a single plant selection. From[4] the time the plant selection was made until the false wild oats were discovered this particular strain was

[4] Information furnished by the courtesy of the Plant Breeding Section of the University of Minnesota.



LOWER AND UPPER SEEDS OF OAT SPIKELETS

These seeds represent the parents and selected plants from the second generation of an oat cross. In the top row are the seeds of the brown hairy Fatua (left) and Garton 748 (right). The other three rows show the paired seeds from twelve second generation segregates. (Fig. 24.)

grown in rows in close proximity only to other selections of Victory and the check (Improved Ligowa). The Garton 784 selection in which false wild oats were found, was made in 1915. The varieties or the pure line selections which were grown after the year 1916 in rows adjacent to this particular selection of Garton 784 were all white-seeded forms and most of them were

liguled. In 1916 the rows grown adjacent to this selection of Garton 784 consisted of other pure line selections of the same variety.

It was pointed out above that all homozygous and heterogygous false wild Garton 784 as well as cultivated Garton 784 had black seeds and the leaves were non-liguled. If false wild oats arose in this instance because of natural crossing between the Garton 784 selection and other cultivated forms, segregation with respect to seed color would be expected. Moreover, segregation with respect to the ligule character would also be expected provided the natural cross was between liguled and non-liguled forms.

Natural crossing occasionally occurs in oats as has been pointed out by Tschermak (1901), Fruwirth (1909), and Pridham (1916). A few years ago Professor A. C. Arny of University Farm, St. Paul, Minnesota, called the writer's attention to what apparently was a natural cross between a fatua and a sativa oat. The particular individual plant row showed segregation typical of an F_2 generation of a fatua-sativa cross. It is possible that once the mutation has occurred which produces false wild oats, their further dissemination is facilitated by natural crossing. There is also the possibility of confusing segregates of a fatua-sativa natural cross with false wild oats as described in this paper.

CONCLUSION

False wild oats were discovered in three very different varieties of cultivated oats namely, Victory, Garton 784, and Aurora. In view of the evidence presented the origin of these aberrant forms may be attributed more logically to mutations than to natural crossing.

BIBLIOGRAPHY

Fruwith, C., 1909. Die Züchtung der landwirtschaftlichen Kulturpflanzen. Paul Parey, Berlin, Bd. IV, 2 Auflage, pp. 324–365.

Love, H. H. and Craig, W. T., 1918. Small grain investigations. *In* Jour. Heredity 9:67–76.

Nilsson-Ehle, H., 1909. Kreuzungsuntersuchungen an Hafer und Weizen. Lunds. Univ. Arsskr. N. F. Afd. 2, Bd. 5, Nr. 2, 122 pp.

————, 1911. Ueber Fälle spontanen Wegfallens eines Hemmungsfaktors beim Hafer. Zeitschr. für Induk. Abstamm. u. Vereb. 5:1–37.

Pridham, J. T., 1916. Oat breeding experiments. *In* Agri. Gaz. N. S. Wales 27:457–461.

Surface, F. M., 1916. Studies on oat breeding. III. On the inheritance of certain glume characters in the cross A. fatua X A. sativa, variety Kherson. *In* Genetics 1:252–286.

Tschermak, E. von, 1901. Ueber Züchtung neuer Getreiderassen mittelst künstlicher Kreuzung. Zeitschr. f. d. Land. Versuch. in Oest. 4:1029–1060.

————, 1914. Die Verwertung der Bastardierung für phylogenetische Fragen in der Getreidegruppe. Zeitschr. für Pflanzenzücht 2:308–311.

Zade, A. 1912. Der Flughafer. Deut. Landw. Gesell. Ab., 279:1–91.

————, 1918. Der Hafer, G. Fischer, Jena. pp. 217–225.